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Cleaning 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, so a limited number of groups containing similar products are defined. The information for each group of products is described in a fact sheet. Paint, cosmetics, children's toys and pest control products are examples of fact sheets which have been published already.
This fact sheet covers the use of cleaning products by consumers. In the fact sheet 36 product categories are described including laundry detergents, dishwashing products, abrasives and toilet cleaners. To assess exposure of compounds in the cleaning products default values for all 36 product categories have been determined.

Key words: cleaning products, consumer products, exposure, consumer, risk, compounds

Rapport in het kort

Factsheet Reinigingsmiddelen

Ten behoeve van de schatting van de risico's voor de consument

Een snelle, transparante en gestandaardiseerde blootstellingsschatting van reinigingsmiddelen is dankzij een nieuwe factsheet voor het computerprogramma ConsExpo nu mogelijk.

ConsExpo 4.0 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 inhalatie en via orale opname).
Bij het ConsExpo programma hoort ook een database, waarin standaardwaarden voor vele product typen en voor een groot aantal blootstellingsscenarios worden aangeboden. De beschrijving van deze achtergrondinformatie bij deze standaardwaarden wordt gerapporteerd in zogenoemde 'factsheets'.
In dit rapport, factsheet reinigingsmiddelen, is de meest recente informatie bijeengebracht om de blootstelling aan stoffen uit reinigingsmiddelen te berekenen. De verschillende typen reinigingsmiddelen zijn verdeeld in 36 categorieën, bijvoorbeeld wasmiddelen, afwasmiddelen, schuurmiddelen en toiletreinigers. Voor iedere categorie wordt de samenstelling en gebruik van producten uit die categorie beschreven. Daarnaast wordt aangegeven welk model of modellen van ConsExpo het meest geschikt is om de blootstelling uit te rekenen en worden voor alle gegevens die nodig zijn voor de berekening standaardwaarden ingevuld. Naast deze factsheet reinigingsmiddelen zijn er ook factsheets voor ongediertebestrijdingsmiddelen, verf, cosmetica en desinfectantia.

Trefwoorden: reinigingsmiddelen, consumentenproducten, blootstelling, consument, risico, stoffen

Contents

Summary

Exposure to and intake of compounds in consumer products are assessed using available mathematical models. Calculations are carried out with the computer program ConsExpo (Consumer Exposure). Given the huge number of consumer products, it is not possible to define exposure models and parameter values for each separate product, so a limited number of main categories containing similar products are defined. The information for each main category is described in a fact sheet. Paint, cosmetics, children's toys and pest control products are examples of fact sheets which have been published already.
This fact sheet covers the use of cleaning products by consumers for 36 product categories including laundry detergents, dishwashing products, abrasives and toilet cleaners. Information is given on the composition and the use of products within a product category. Default models and values for all 36 product categories have been determined to assess exposure and intake of compounds in the cleaning products.

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 gebruik gemaakt van het computerprogramma ConsExpo. Het grote aantal consumentenproducten verhindert dat voor elk afzonderlijk product blootstellingsmodellen en parameterwaarden vastgesteld kunnen worden. Daarom is een beperkt aantal hoofdcategorieën met gelijksoortige producten gedefinieerd. Voor elke hoofdcategorie wordt de informatie in een factsheet weergegeven. Verf, ongediertebestrijdingsmiddelen, kinderspeelgoed en cosmetica zijn voorbeelden van factsheets die al gepubliceerd zijn. In deze factsheet wordt informatie gegeven over het gebruik van reinigingsmiddelen.
Het gebruik van reinigingsmiddelen die verkrijgbaar zijn voor de consument wordt beschreven met behulp van 36 productcategorieën, zoals wasmiddelen, afwasmiddelen, schuurmiddelen en toiletreinigers. Het gehele gebied van het gebruik van reinigingsmiddelen door consumenten wordt met deze productcategorieën bestreken. Voor elke productcategorie wordt ingegaan op samenstelling en gebruik van het type producten binnen de categorie. Om de blootstelling en opname van stoffen uit reinigingsmiddelen te kunnen schatten en beoordelen zijn voor elke productcategorie defaultmodellen met defaultwaarden voor de parameters vastgesteld.

1 Introduction

1.1 General

Descriptive models have been developed within the National Institute for Public Health and the Environment (RIVM) to be able to estimate and assess the exposure to substances from consumer products and the uptake of these by humans. These models are brought together in a computer program called ConsExpo 4.0. 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, cosmetics, children's toys, cleaning products and pest control products. The relevant information with respect to the estimate of exposure to and the 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 number of product categories defined within the cleaning products main category has been kept to a minimum. The 'cleaning products' main category includes the following product categories: laundry products, dishwashing products, all-purpose cleaners, abrasives, sanitary products, floor and furniture cleaners. The composition and the use of the type of products within the category are examined for every product category. To estimate the exposure and uptake of substances from cleaning products, default models with default parameter values are determined for every product category in this fact sheet. The default models and default parameter values are available via a database. Using these data, standardized exposure calculations for consumers resulting from the use of cleaning 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 the consumer exposure assessment for New and Existing Substances in scope 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 the consumer exposure to biocides. (Technical Notes for Guidance (TNsG): Human Exposure to Biocidal Products – Guidance on Exposure Estimation[41)] (http://ecb.jrc.it))

ConsExpo is built up using data about the use of products, and from 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, i.e. the inhalation, dermal or oral route. The most appropriate exposure scenario and uptake model is chosen 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 is 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 4.0, the most recent ConsExpo version, is described in detail in Delmaar et al.[1)].

ConsExpo 4.0 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 distributed input parameters 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 in the Netherlands (RIVM; www.rivm.nl/consexpo).

1.3 Fact sheets

This report is one of a series of fact sheets that describes a main category of consumer products, such as paint, cosmetics, children's toys, pest control products and in this report, cleaning 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'[2)], gives 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 is shown
- parameters such as the ventilation rate and room size
- parameters such as body weight and the surface of the human body, or parts thereof

In the facts sheets, information about exposure to chemical substances is collected into certain product categories. These categories are chosen so that products with similar exposures are grouped. On the one hand, the fact sheet gives general background information; while on the other hand, it quantifies 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 changed. 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 (data base 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 physical-

chemical properties of the compound.

1.3.1 The consumer and exposure

Non-professional use only

The default values in the fact sheets have been collected for consumers (private or non-professional users). They are not aimed at describing exposure for people who professionally work with cleaning products, such as in hospitals and in public services, for example. This fact sheet therefore only describes cleaning products which are available to the consumer for private 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 and uptake of cleaning products by professional users. Of course, the differences in products and product use between the consumer and those using cleaning products professionally must be taken into account.

Groups to consider

Two groups can be distinguished in the exposure assessment for consumers: the group experiencing the highest exposure during use (in most cases the user) and the group exposed after application (e.g. children). The person applying the product (the user) is the one actually using the cleaning product and, if necessary, diluting it to the required concentration ('mixing and loading'). It is expected that the user will be exposed to high levels during mixing and loading and during application.

As both men and women use cleaning products, the default values for body weight and surface areas of body parts are given for adults. For men and women, values for body weight and surface area are given in the General Fact Sheet[2)].

In the post-application phase, for relevant scenarios, young children can be relatively high exposed, due to their specific time-activity pattern (crawling on treated surfaces, hand-to-mouth contact, and relatively low body weight).

In the present fact sheet, if relevant, the exposure calculations are based on children between 10 and 11 months, since this group demonstrates the most crawling and hand-mouth contact, combined with a relatively low body weight. Crawling children exposed after application are only regarded for the product 'carpet powder' from the category floor products.

More information on specific exposure scenarios for children is provided in Van Engelen and Prud'homme de Lodder [19)].

1.3.2 'Reasonable worst case' estimate

The basis for the calculation and/or estimation of the default parameter values is a realistic worst-case scenario, and considers consumers who frequently use a certain cleaning product under relatively less favourable circumstances. For example, when using a cleaning spray, basic assumptions are relatively frequent use, application of a relatively large amount in a small room with a low ventilation rate, 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 actually too little data 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 for all parameter values a 75th /25th percentile is calculated or estimated, 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.
The result is a 'reasonable worst-case'estimate for consumers who use relatively large amounts of cleaning products under less favourable circumstances.

1.3.3 HERA project

The HERA project is a voluntary industry programme to carry out Human and Environmental Risk Assessments on ingredients of household cleaning products. It is a unique European partnership established in 1999 between the

- A.I.S.E: International Association for Soaps, Detergents and Maintenance Products
- Cefic: European Chemical Industry Council

The A.I.S.E. represents the formulators and manufacturers of household cleaning products and Cefic represents the suppliers and manufacturers of the raw materials.

The objective of HERA is to provide a common risk assessment framework for the household cleaning products industry, and show that this process will deliver evaluated safety information on the ingredients used in these products in an effective and transparent way. This process is intended to support a risk-based approach to chemicals legislation in the European Union, and may serve as a pilot for the application of the same process in other sectors and/or geographical areas.
The text above is derived from the website www.heraproject.com

From different compounds such as Fatty Acid Salts and Zeolite A, a human risk assessment is made. For the consumer's exposure, the known and probable uses of detergent and cleaning products are applied in the assessments. However, dermal exposure is calculated by using the *maximum* values (AISE table, 2002) resulting in a worst-case estimate.
In this fact sheet, for the different parameters such as frequency and amount, the default values are 75th percentile values; thus, resulting in a 'reasonable worst-case' estimate (see subsection 1.3.2). Therefore, the used default values may differ from the values in the HERA risk assessments.

1.3.4 Reliability of the data

A number of parameters are difficult to estimate based on the 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-factor) is introduced[2)], which is in fact a grading system for the value of the estimate of the exposure parameter. Low Q-factors 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, adapted. If representative data is supplied by applicants or producers, it can replace the default values. High Q-factors indicate that the defaults are based on sufficient (or more) data. These defaults generally require less attention. It is possible that they will need to be adapted according to the 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. A Q-factor is given to all

parameter values in the fact sheets, indicating the reliability of the estimate of the default value. The quality factor range has been adapted and it can have a value of between 1 and 4. In previous fact sheets, the quality factor ranged from 1 to 9. Table 1 shows the meaning of the values of the quality factor.

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, cleaning products are classified into product categories, which are drawn up according to the type of product. The aim is to reduce the large number of individual products and applications to a limited number. Therefore, the main category cleaning products are divided into 36 product categories. In Table 2 the different product types and product categories are mentioned. For calculating the exposure due to the use of these product categories, the defaults are given in this fact sheet. Only those product categories are described when exposure to that product category is expected. Further, the product categories should cover the whole area of exposures due to the application of cleaning products.
For tablets (laundry products or dishwash products) the inhalation and dermal exposure is considered to be negligible; further, the exposure of loading salt (dish wash product) is not regarded. Therefore, these products are not mentioned in Table 2 and no defaults are given for salt and tablets.

1.4.1 Cleaning versus caring

Products like shoe polish products do not belong to the cleaning products; however, they can combine the task of cleaning and polishing. The difference is difficult to make between cleaning and polishing products; furthermore, their application is comparable. Therefore, in this fact sheet no distinction is made between polishing, caring and cleaning products. The application of the different products is similar and thus, the scenarios and the default values of these products are given. The following cleaning/ polishing products are discussed: floor polishes, metal polishes, furniture and leather products, and shoe polish products. Strictly speaking, floor strippers and floor sealers do not belong to the cleaning/ polishing products either, but they are discussed in section floor products.

Table 2: Product categories cleaning products

Product type	**Product categories**
Laundry products	Powders Liquids Fabric conditioners Laundry pre-treatment products - Sprays - Liquids - Pastes
Dishwashing products	Hand dishwashing, liquids Machine dishwashing products - Powders - Liquids
All-purpose cleaners	Liquids Sprays Wet tissues
Abrasives	Liquids Powders
Sanitary products	Bathroom cleaners - Sprays - Liquids Toilet cleaners Toilet rim cleaners
Floor and furniture product	Floor products - Liquids - Wet tissues - Polishes - Strippers - Sealers Carpet products - Liquids - Spray extraction machine - Powders - Spray foams Furniture and leather products - Furniture polish - Leather furniture spray
Miscellaneous	Glass cleaners Oven cleaners Metal cleaners Drain openers Shoe polish products - Spray - Cream Pressure washers

1.5 Ingredients in cleaning products

The cleaning products contain compounds in order to clean the laundry, the dinnerware or surfaces in the house. The ingredients are classified into five general types i.e. surfactants, builders, solvents, anti-microbial compounds and miscellaneous[3)].

- *Surfactants*

The surfactants are by far the most important group of detergent ingredients. Surfactants improve the wetting ability of water, remove soil with the aid of wash action and they emulsify, solubilize or suspend soils in the wash solution. Due to different response to water hardness and due to their different ability to remove certain types of soil detergents contain surfactant mixtures in which the surfactants complemented each other's properties[4,33)]. Surfactants are classified in anionic, non-ionic, amphoteric and cationic surfactants and their mixtures are used mainly for cleaning[33)]. Cationic surfactants are often used as laundry conditioner[3,4)].

Examples of surfactants:
Anionic surfactants
- Linear Alkylbenzene Sulphonate (LAS)
- Alkyl Sulphates (AS)
- Alkyl Ethoxy Sulphates (AES)
- Soap or fatty acid salts (FAS)
- Secundair Alkane Sulfonate (SAS)

Non-ionic surfactants
- Alkyl polyethyleneglycol ethers (AEO)
- Fatty acid alkanol amides (FAA)
- Alkyl polyglucosides (APG)

Amphoteric surfactants
- Alkyl betaines
- Amino alkylamino acids

Cationic surfactants
- Quaternary ammonium chlorides e.g. dialkyl dimethyl ammonium chlorides

- *Builders*

Builders improve the cleaning effectiveness of the surfactants because they soften water by removing metal ions like calcium and magnesium [3,4,33)]. Examples of builders:
Alkalis
- Sodium (bi) carbonate
- Sodium silicate

Ion exchangers
- Zeolite
- Polycarboxylate

Complexing agents
- Citric acid/ citrate
- Phosphonates
- EDTA: ethylenediamine tetra-acetic acid
- NTA: nitroloacetic acid

- *Solvents*

Solvents are added to increase the cleaning effect of surfactants by dissolving oil and grease.

Their positive influence only exerts itself when the cleaner is used undiluted[3]. Besides they dry quickly on the cleaned surface. The water-soluble solvents can be divided into three categories[5]:
- alcohols: ethanol and isopropanol
- glycols: glycerol and propylenglycol
- glycol ethers: butyl(di)glycol, ethyl-glycol and propylene-glycol ethers

- *Miscellaneous*

Other ingredients such as bleaching agents, enzymes, abrasives, acids, fragrances, dyes, and preservatives may be added to cleaning products.

The bleaching systems in household products are:
- Peroxide or active oxygen bleach
  Hydrogen peroxide is the base of the bleaching agents which contain active oxygen. In household products compounds such as sodium perborate tetrahydrate or sodium percarbonate[4] are preferred. Tetra-acetyl-ethyleendiamine, TAED, is an activator for the bleaching agent and the compounds sodium carbonate and hydrogen peroxide are formed[32]. Activated bleaching systems provide effective bleaching at today's lower wash temperatures for the laundry or machine dishwash.
  In toilet cleaners, active oxygen bleach is used for surface cleaning and sanitizing.
- Hypochlorite bleaches
  Hypochlorite bleaches are used in hard surface cleaning and sanitizing. This can be done in a separate step of the cleaning task e.g. cleaning the toilet with bleach or the bleach is an incorporated ingredient in the cleaning product e.g. an abrasive liquid containing bleach.

Enzymes aid in breaking down complex soils and they are active against one specific kind of soil. Therefore, different types of enzymes are used in household products such as
- proteases for breaking down proteins like blood, milk or cacao
- lipases for breaking down fat containing soils like frying fat, sauces or cosmetics
- amylases for splitting up starch coming from potatoes, rice and pasta
- cellulases for removing pills from cotton fabrics which make fabrics preserve their colour

Enzymes can be found in laundry products, machine dishwash products, in spot removers and household cleaners[32,33].

Anti-redeposition agents in laundry products aid in preventing loosened soil from redepositing onto cleaned fabrics. Examples are carboxymethylcellulose (CMC) and carboxymethylstarch (CMS).

Abrasives can be found in scouring products and consist of small particles of minerals. They are differentiated by their relative hardness. In scouring cleaners, the used minerals are silica, feldspar, aluminium oxide and calciumcarbonate[33].

Acids like formic acid, lactic acid, sulphuric acid or phosphoric acid can dissolve calcium and metal salts; they find use in tub, tile, sink and toilet bowl cleaners[33].

Polymers are compounds whose molecules are very large, compared to most of the other ingredients found in household cleaners. Polymers can be used as builders and ist as thickening agents; the accompanying examples are polycarboxylates and polyglycols

respectively. In floor products, polymers such as polyethylene resins and polyacrylates form films and these protect the surface and may provide a shine as well[33)].

Preservatives protect the product against decay, discoloration, oxidation and bacterial attack[32)].

Fragrances cover the base odour of the chemicals used in cleaning products and they leave a pleasing scent after cleaning[32)].

General information about cleaning products is given on the website www.isditproductveilig.nl (in Dutch). The information is given to consumers and to (real) users such as butchers and bakers, so they can use cleaning products in a safe way.

1.6 Uncertainties and limitations

This fact sheet presents a number of default parameters which can be used in the exposure assessment of the non-professional user of cleaning products, when using ConsExpo. The model approach makes it possible to extrapolate 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 one is alert in the choice of parameter values and the determination and improvement of default values. Scenarios and the related parameters can have a major influence on the final exposure estimate. It should also be noted that the models used in ConsExpo are developed for particular purposes. In the absence of specific models, one is forced to use a model developed for another purpose.

In the next versions of ConsExpo and/or in the update of this report (if more data is available) these aspects will be further elaborated on. Depending on what is needed, further adapting exposure models for certain scenarios can be considered, or developing new models, for example.

2 Scenarios and models

2.1 Introduction

The use of several cleaning products is comparable. For these similar applications the same scenario can be used, which are:

- loading: filling a (dish) wash machine (laundry products, dish-wash products)
- mixing and loading: making ready for use (liquid all-purpose cleaners, bathroom cleaners)
- cleaning a surface (all-purpose cleaners, toilet cleaners)
- spraying with a trigger spray or aerosol can (glass cleaners, all-purpose cleaners, furniture polish sprays)

For these applications, default exposure models are chosen and filled in with default parameter values.

In the following chapters 3 to 9, the default models for the exposure and the default models for the uptake are determined for each product category of Table 2; further, for these models default parameter values are suggested. Only relevant exposure routes are described. Table 3 shows all of the models used in this fact sheet to describe mixing and loading and the different types of applications. The models themselves and the meaning of the parameters are not considered here; these are described in the help file and user manual of ConsExpo 4.0[1)].

Table 3: Overview of the models used for applications of cleaning products

Situation		**Route of exposure**		
Before application	**Model**	**Inhalation**	**Dermal**	**Oral**
M&L[a)] liquid	Exposure model Uptake model	Evaporation Fraction	Instant application Diffusion through skin	
M&L[a)] powder (dishwash, laundry)	Exposure model Uptake model	Instant release Fraction		
During application				
General	Exposure model Uptake model	Evaporation Fraction	Instant application Diffusion through skin	
Trigger sprays	Exposure model Uptake model	Spray Fraction	Constant rate Fraction	Spray Fraction
Powders (abrasive, carpet)	Exposure model Uptake model	Spray Fraction	Constant rate Fraction	Spray Fraction
Post-application				
Laundry products	Exposure model Uptake model		Migration Fraction	
Dishwash products	Exposure model Uptake model			Direct intake Fraction
Carpet powder [b)]	Exposure model Uptake model		Rubbing off Fraction	Direct intake [c)] Fraction

a) M&L: mixing and loading
b) exposure of crawling child
c) via hand-mouth contact

2.2 Mixing and loading cleaning products

Charging the (dish) washing machine with (dish) washing products may lead to inhalation exposure. Using powder products may lead to dust; therefore, in subsection 2.2.1 the default model and default parameters are described to assess the inhalation exposure to dust. Filling the (dish) wash machine with liquid products or mixing and loading liquid cleaners into water, may lead to inhalation exposure due to evaporation of volatile chemical substances. The applied model and default parameter values are described in subsection 2.2.2. There could also be dermal exposure due to spills; the corresponding model is described in subsection 2.2.3.

2.2.1 Exposure during loading the (dish) wash machine with powder

The use of (dish) washing powder may lead to dust. (Dish) washing powder mainly contains large particles; a very small amount consists of minute dust particles. In 'Air Pollution: Its Origin and Control'[6], several sizes of common particles are given e.g. cement dust particle size ranges from 3-70 µm, mine dust from 1-100 µm and talcum powder from 0.7-60 µm. There are no data available of the particle size of (dish) washing powder dust and its distribution.
Only data from Van de Plassche et al.[7] were found: a cup containing 200 gram of washing powder can generate 0.27 µg dust. The term dust was not defined and the used method for determining the amount of dust was not described. Worst-case, it is assumed that the total amount of dust is airborne.
For the assessment of inhalation exposure, the spray model is an option; however, several parameters are not known. The inhalation exposure can be assessed with the model 'instantaneous release'. This model estimates the concentration based on information on quantity of product, weight fraction of chemical, room size and on ventilation.

Scenario
A private user loads powder into a (dish) wash machine. The dust of (dish) wash powder results in inhalation exposure.

Inhalation: instantaneous release

- *Product amount*

In this case, the product amount is equal to the total amount of airborne dust. The default value for amount is set at 0.27 µg, the value given by Van de Plassche et al.[7] (see above). Considering the great uncertainty, the quality factor is set at 1.

- *Room volume*

'Room volume' is interpreted here as 'personal volume': 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, as it enables the evaporation of the compound from the concentrate to be described. Since no data with regard to the personal volume were found, a quality factor Q of 1 is assigned.

- *Ventilation rate*

The ventilation rate that Bremmer et al.[2] give for the room considered is taken as default value. To what extent this value is applicable to the 'personal volume' of 1 m^3 around the user is unknown, therefore the quality factor is set at 1.

2.2.2 Inhalation exposure during mixing and loading liquid cleaners

During loading the (dish) wash machine with liquid products or during mixing and loading liquid cleaners into water inhalation exposure can occur due to evaporation from the bottle with the product. Dermal exposure can occur, due to liquid spills (see subsection 2.2.3).

During (mixing and) loading a liquid cleaner, the compound evaporates from a one-litre bottle with a not-too-small circular opening with a 5-cm diameter, resulting in a surface area of 20 cm^2. During mixing and loading the user stays in the vicinity of the evaporating compound and it is therefore assumed that the user is present in a 'personal volume' instead of a room volume. To calculate the exposure of the user during mixing and loading liquid, the 'evaporation model' is used for inhalation exposure. This model defines an event in which compounds evaporate from the liquid into the air of the room.

Inhalation: vapour, evaporation from constant surface

- *Product amount*

This parameter is for limiting the evaporated amount of compound from the product. It is not the *used* product amount but half of the bottle content. For a one-litre bottle the averaged amount liquid in the bottle is estimated at 500 g (density 1 g/cm^3), which is set as default value.

- *Release area*

No data was found for this parameter. It is assumed that evaporation takes place from a bottle with a not-too-small circular opening with a 5 cm diameter which gives a release area of 20 cm^2.

- *Room volume*

'Room volume' is interpreted here as 'personal volume': 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, as it enables the evaporation of the compound from the concentrate to be described. Since no data with regard to the personal volume were found, a quality factor Q of 1 is assigned.

- *Ventilation rate*

The ventilation rate that Bremmer at al.[2)] give for the room considered is taken as a default value. To what extent this value is applicable to the 'personal volume' of 1 m^3 around the user is unknown, therefore the quality factor is set at 1.

- *Molecular weight matrix*

The parameter 'molecular weight matrix' is the molecular weight of the 'other' components in the product. In Fact Sheet Paint[9)], this parameter is extensively discussed. The 'molecular weight matrix' is roughly given by M_w / fraction solvents. For example, if the matrix is water and the water fraction is 0.3, the molecular weight fraction is approximately 18 g/mol / 0.3 = 60 g/mol.

2.2.3 Dermal exposure during mixing and loading liquid cleaners

During mixing and loading a liquid cleaner e.g. dish wash products, all-purpose cleaners, abrasive liquids, sanitary cleaners, dermal exposure could occur. This is due to liquid spills around the opening of the bottle, which depends on the size of the opening and the way a

product is used. The consumer can use the cap for loading the liquid; when replacing the cap, the remnants of the cleaning product may drip down[10]. Furthermore, when mixing and loading a liquid cleaner in a bucket, there could be spatters of the cleaning product.
For this purpose the model 'instant application' is used. This model describes exposure assuming that all compound in the product is directly applied to the skin.

Dermal exposure: instant application

- *Product amount (upon skin)*

Dermal exposure of consumers to biocides is described in the TNsG[41] for dispersing a concentrate from a one-litre can and diluting with water in a small vessel (200 ml concentrate plus 2.3 L water). The dermal exposure of hands results in a range from 0 to 3.2 mg (n=10). The non-zero values varied from 0.33 to 3.2 mg (n=8).
For dermal exposure of pesticides used by amateurs, the UK POEM model[43] 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 per operation. Containers of 5 litres with narrow closures or with 45/63 mm closures give a dermal exposure of 0.2 ml and 0.01 ml per operation, respectively (see Table 4).

Table 4: Hand contamination per operation of mixing and loading[43]

Container [litre]	Type of closure	Contamination [ml/ operation]
1	Any closure	0.01
2	Any closure	0.01
5	Narrow closure	0.20
5	45 or 63 mm closure	0.01

Using these data for mixing and loading, the default value for dermal exposure is set at 0.01 ml or 0.01 g (density 1 g/cm^3). For comparison, one small drop liquid is about 0.02 ml.

2.3 Cleaning surfaces

For the assessment of inhalation exposure during cleaning surfaces with (diluted) products, the evaporation model is used. This model is used for surface cleaning products such as all-purpose cleaners (liquid and tissues), abrasive liquids, and all kinds of sprays during the 'leaving on and cleaning phases'. When leaving a surface spray to soak in and during cleaning, inhalation exposure occurs because of evaporation from the product on the surface.

For estimating dermal exposure during cleaning, there are no data found for the amount contacting the skin. It is assumed that 1 % of the product amount gives dermal exposure, unless it is stated otherwise.

In the case of *diluted* cleaning products, it is assumed that not the total amount of *diluted* product is in contact with the skin but only a layer around the exposed skin. The TGD[11] estimated the thickness of a product layer on the skin at 0.01 cm. For dermal exposure to the dilution, the amount can be calculated by multiplying the exposed area (cm^2) with 0.01 cm. For instance, when the hands are exposed to a diluted dish-wash product, the surface area of the hands i.e. 860 cm^2 should be multiplied with 0.01 cm resulting in 8.6 cm^3 or 8.6 g (density 1 g/cm^3) amount of diluted product.

2.4 General parameters for the spraying process

2.4.1 Inhalation exposure during spraying

During spraying, inhalation can take place. Droplets of the product or the evaporated compound can be inhaled. Sprays produce an aerosol cloud of very small to small droplets. The speed with which the droplets fall depends on the size of the droplet. Smaller droplets stay longer in the air.

To calculate the inhalation exposure, the 'spray model' from ConsExpo 4.0 is used for all spray applications. Examples are cleaning sprays such as glass cleaners, all-purpose cleaners, spray spot removers and oven cleaners. The mentioned sprays are all surface sprays. For spraying cleaning products, spray cans and trigger sprays can be used. 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 the indoor inhalation exposure to slightly evaporating or non-volatile compounds in droplets that are released from a spray can or trigger spray[1,49]. 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 is defined as compounds with vapour pressure > 0.1 Pa, non volatile < 0.01 Pa and slightly volatile between 0.01and 0.1 Pa[35].

Inhalation: spray model

- *Spray duration and exposure duration*

Weerdesteijn et al.[12] studied the use of cleaning the kitchen working top with sprays. In this pilot study the area was 60 cm x 60 cm. The 75th percentile of the duration of spraying was 5.15 seconds (mean 4.2 sec; S.D. 1.40; N=10) and the 75th percentile of rinsing and cleaning was 39.59 seconds (mean 22 sec; S.D. 25.87; N=10). The duration of spraying and rinsing/ cleaning is directly related to the size of the cleaned area; therefore, the use duration is extrapolated linearly from the pilot. The default values for spraying and for cleaning are set at 14.3 sec/m^2 and 110 sec/ m^2, respectively.
The phase of leaving the product to soak is independent of the size of the area to be cleaned; it is more dependent on the cleaning person, on the extent of filthiness and on the product type. E.g., the time of leaving an oven cleaner on the surface is much longer than the time of leaving a glass cleaner on the surface.
The exposure duration is the sum of spraying time, time of leaving on, the cleaning time and the time staying in the specified room after spraying and cleaning.

- *Mass generation rate*

TNO-PML[42] has investigated the mass generation rate of 23 aerosols spray cans and trigger sprays, including three cleaning sprays and one polish spray. The mass generation rate of full and of nearly empty cans was measured. The median of all full spray cans and trigger sprays was 1.0 g/sec; the 75th percentile was 1.5 g/sec. No distinction could be made between aerosol cans and trigger sprays, the 75th percentile of the full trigger sprays was 1.5 g/sec, the 75th percentile of the full spray cans 1.6 g/sec. The mass generation rate of the nearly empty spray can was in some cases 80-90 % of the full can, in some other cases only 30 % of the full can. Table 5 gives the mass generation rate of the investigated cleaning/ polish sprays.

Table 5: Mass generation rate of cleaning sprays[42)]

Cleaning/ polish sprays	**Mass generation rate of a full container** [g/sec]	**Mass generation rate of a nearly empty container** [g/sec]
All-purpose cleaning trigger spray	1.17	1.08
Bathroom cleaning trigger spray	1.25	1.22
Anti-grease cleaning trigger spray	1.28	1.03
Furniture polish spray can	1.80	1.15

Based on the literature as described in Pest Control Products Fact Sheet[13)], and on the TNO-PML investigation it is concluded that no distinction can be made between spray cans and trigger sprays or between sprays used for a specific application. For all spray cans and trigger sprays the mass generation rate is set at 1.5 g formulation/sec. This value is also used for laundry spray spot remover, furniture polish spray and shoe polish spray.
Assuming that active spraying actually occurs about half of this time, the mass generation rate for cleaning trigger sprays can be calculated as 0.75 g/sec.

Weerdesteijn et al.[12)] investigated the use of cleaning sprays (trigger sprays). For an area of 60 x 60 cm she found an average amount of 3.35 g (S.D. 0.98) with a calculated 75 percentile of 4.016 g. To calculate the mass generation rate of cleaning sprays the used amount is divided by the spray duration i.e. 4.016 g/ 5.15 sec = 0.78 g/sec which is according to the mass generation rate of 0.75 g/sec found above.
The default value for mass generation rate is set at 0.78 g/sec and it is used for the following trigger sprays: all-purpose spray, bathroom spray, glass spray and oven spray.

- *Initial particle distribution*

The droplet size is an important parameter when estimating the exposure. Smaller drops fall at a lower speed and stay in the air for longer. The 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 meters is calculated at 11 sec, and for droplets of 10 µm it is calculated at 17 min[8)]. If a larger droplet is sprayed, part of the aerosol cloud will consist of finer droplets which stay in the air for longer, as a result of edge effects around the nozzle and the 'bounce back' effect due to spraying onto a surface. Further, the solvent in (large) droplets might evaporate resulting in smaller droplets.
'Assessment of human exposure to biocides' from the Biocides Steering Group[8)] gives a WHO classification concerning the droplet size of sprays (see Table 6).

Table 6: Classification of aerosol droplets[8)]

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

In the same study, a classification is also given for the droplet size for various types of agricultural use (see Table 7).

Table 7: Droplet size for different types of agricultural use [8)]

Aim of use	**Droplet diameter [µm]**
Flying insects	10-50
Insects on plants	30-50
Precipitation on surface	40-100
Application on the ground	250-500

The Dutch Aerosol Association[15)] 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.[16)] measured the droplet size of an aerosol can with 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: 10 % of the particles have a droplet size of 60 µm, 80 % have a droplet size of 20 µm and 10 % of the particles have a droplet size of 5 µm. A spray for air space applications generally has a smaller droplet diameter than a spray for surface applications.

TNO-PML[42)] has investigated the initial particle size distributions from aerosols spray cans and trigger sprays. Among other types of cleaning products (all-purpose cleaner, bathroom cleaner, anti-grease cleaner and furniture polish) were studied. 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. The percentiles of different spraying devices used for surface spraying are given in Table 8. The 10^{th} , 50^{th} , and 90^{th} 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 (in µm).

Table 8: Percentiles of the initial volume distribution of different spraying devices [42)]

Surface spraying		**Percentiles of the initial particle distribution [µm]**		
Aerosol spray cans	**Content**	D_p (0.10)	D_p (0.50)	D_p (0.90)
Furniture polish	Full	30	63	114
	Nearly empty	52	98	154
Cockpit spray	Full	18	55	113
	Nearly empty	19	50	98
Textile freshener	Full	32	74	152
	Nearly empty	40	88	162
Wood Preservatives	Full	15	40	106
	Nearly empty	20	52	92
Paint 1	Full	27	114	352
	Nearly empty	20	76	186
Paint 2	Full	11	39	88
	Nearly empty	10	37	101
Plant spray 1	Full	55	97	232
	Nearly empty	20	68	152
Flea spray	Full	9.4	30	142
	Nearly empty	9.8	27	97

Surface spraying		**Percentiles of the initial particle distribution [µm]**		
Trigger sprays	**Content**	D_p (0.10)	D_p (0.50)	D_p (0.90)
All purpose cleaner	Full	46	133	391
	Nearly empty	64	183	478
Bathroom cleaner	Full	59	185	502
	Nearly empty	69	190	490
Anti-grease cleaner	Full	63	160	363
	Nearly empty	72	198	494

For aerosol spray cans and for trigger sprays, the default initial particle distribution is based on above-mentioned data generated by TNO-PML. For aerosol spray cans, the default is a lognormal distribution with median 25 µm, coefficient of variation (C.V.) 0.4 (see Figure 1). For trigger sprays, the default is a lognormal distribution with median 100 µm, coefficient of variation 0.6 (see Figure 2).

Default initial particle distribution for cleaning sprays

Cleaning/ polish spray	**Distribution**	**Median**	**C.V.**	**Q**
Aerosol spray can	Lognormal	25 µm	0.4	3
Surface trigger spray	Lognormal	100 µm	0.6	3

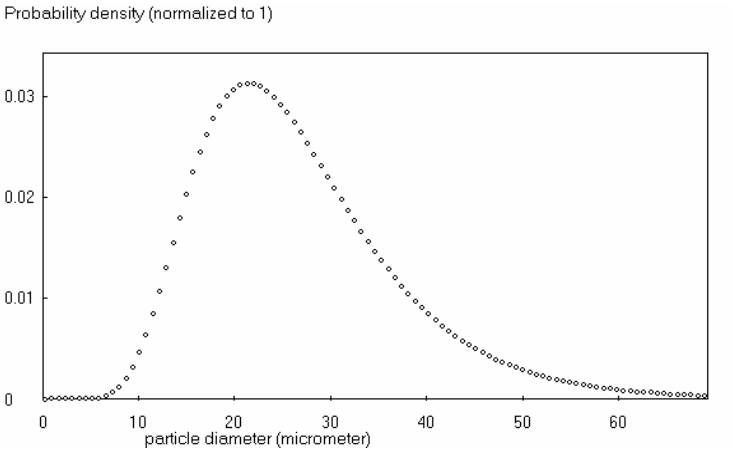

Figure 1: Default initial particle distribution for surface spray cans i.e. a lognormal distribution with median 25 µm (C.V. 0.4)

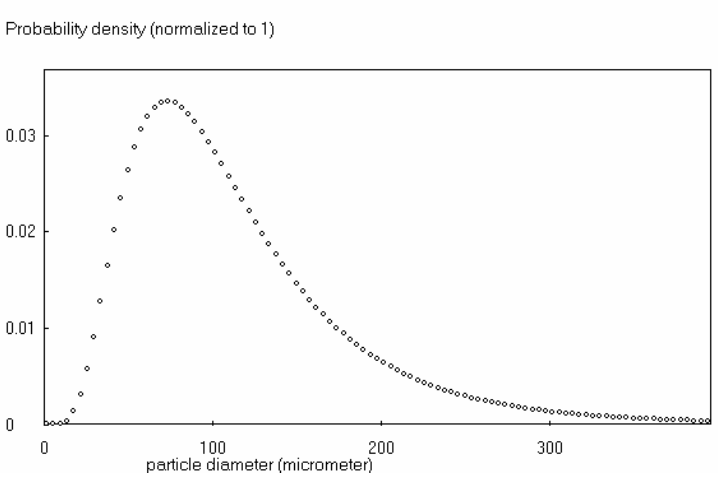

Figure 2: Default initial particle distribution for cleaning trigger sprays i.e. a lognormal distribution with median 100 µm (C.V. 0.6)

- *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 fraction non-volatile material 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 way it is used, i.e. 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[42] survey on the exposure from spray cans and trigger sprays (Delmaar et al., in prep.)[49]. In Table 9 the airborne fractions for the investigated sprays are given; based on these values, default values are set.

Table 9: Airborne fractions of investigated spray cans and trigger sprays

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

Default values for the airborne fraction

Cleaning/ polish spray	Airborne fraction	Q
Surface spray; median of the initial particle distribution < 50 µm	1	2
Surface spray; median of the initial particle distribution ≥ 50 µm	0.2	2

- *Density*

In the spray model the density of the non-volatile fraction is one of the parameters. Many ingredients in cleaning products are made of (very) large organic compounds with densities usually between 1.0 and 1.5 g/ cm^3. The density of salts generally varies between 1.5 and 3.0 g/ cm^3. For a complex mixture of (especially organic) compounds, the density is set at 1.8 g/ cm^3 (see Table 10).
If data concerning the density is lacking, the default value for density non-volatile is set at 1.8 g/cm^3.

Table 10: Default values for density non-volatile compounds

Main ingredient	Density [g/ cm^3]	Q
Large organic compounds	1.5	3
Salts	3.0	3
Complex mixture of compounds, especially organic compounds	1.8	3

- *Inhalation cut-off diameter*

The inhalation cut-off diameter is the measure for the diameter of the spray droplets that can be inhaled and reach the lower areas of the lungs (alveoli, bronchioles, bronchia). Particles that are above 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 micrometer. The default value is set at 15 µm.

2.4.2 Dermal exposure during spraying

To calculate dermal exposure of the user during application the 'constant rate' model from ConsExpo is used for all spray applications. The TNsG[41)] provides data for consumer spraying, for surface spraying with pre-pressurized aerosol spray cans and hand-held trigger sprays. The measured data for dermal exposure have a wide range. For surface spraying these data is used as default value for contact rate.

Dermal exposure: constant rate

- *Contact rate aerosol spray cans*

In the TNsG's[41)] 'Consumer product spraying and dusting' a surface spraying model is stated in which the consumer uses an pre-pressurized aerosol spray can for spraying surfaces i.e. 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. Using these data, the default value for contact rate aerosol spray cans is set at 100 mg/minute.

- *Contact rate trigger sprays*

In the TNsG's[41] 'Consumer product spraying and dusting' a surface spraying model is stated in which the consumer uses a hand-held trigger spray for spraying surfaces i.e. skirting, shelves and horizontal and vertical laminate. The dermal exposure on hands and forearms ranges from 3 to 68.2 mg/min with a 75th percentile of 36.1 mg/min. The dermal contact rate for legs, feet and face ranges from 1.9 to 12.4 mg/min with a 75th percentile of 9.7 mg/min. Using these data, the default value for contact rate for trigger sprays is set at 46 mg/minute.

In Table 11 and 12, an overview is given for the default values of aerosol spray cans and trigger sprays, respectively.

Table 11: Default values for aerosol spray cans

	Default value	**Q**	**References, comments**
Inhalation			
Exposure, spray model			
Mass generation rate	1.5 g/sec	3	See above
Airborne fraction	1 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See above
Initial particle distribution			
Median (C.V.)	25 µm (0.4)	3	See above
Inhalation cut-off diameter	15 µm		See above
Dermal			
Exposure, constant rate			
Contact rate	100 mg/min	3	See above

Table 12: Default values for trigger sprays

	Default value	**Q**	**References, comments**
Inhalation			
Exposure, spray model			
Mass generation rate	0.78 g/sec	3	Alternatively 1.5 g/s for laundry spot remover, see above
Airborne fraction	0.2 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See above
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See above
Inhalation cut-off diameter	15 µm		See above
Dermal			
Exposure, constant rate			
Contact rate	46 mg/min	3	See above

3 Laundry products

Laundry products are detergents for cleaning textiles. Heavy-duty detergents or all-purpose detergents are suitable for all washable fabrics; colour detergents are appropriate for coloured fabrics; light-duty detergents are used for lightly soiled items and for delicate fabrics. Laundry detergents and laundry aids are available as liquids, powders / granules, tablets, gels, sticks, sprays, and as pumps.

Exposure of laundry products can occur by:
- inhalation of detergent dust or aerosol particles or inhalation of volatile compounds
- direct skin contact with undiluted (laundry pre-treatment) or with diluted laundry products (hand wash)
- indirect skin contact via release of chemicals from textile fibres to the skin

Default models with the default parameter values are described for detergent powders, liquid detergents, fabric conditioners and laundry pre-treatment products.
For the inhalation exposure, the ‘instantaneous release’ model is used for loading powder detergents, the model ‘evaporation from constant surface’ for loading liquid detergents. For the inhalation of dust particles, the ‘spray model’ is appropriate. As a substantial number of parameter values are lacking, the spray model is not applied for the exposure assessment. For the dermal exposure, the model ‘instant application’ is used for direct skin contact and the model ‘migration’ is applicable for indirect skin contact.

For granules, it is assumed that a maximum of 10 % is present in the form of powder[37)]. The inhalation exposure is therefore expected to be 10-fold lower than the exposure of a powder. For tablets, the inhalation and dermal exposure is considered negligible; there are therefore no defaults given for tablets.

3.1 Detergent powders

Composition

General formula of detergent powder [32)]

Laundry products Powder	**Heavy duty Detergents %**	**Heavy duty colour Detergents %**	**Light duty Detergents %**
Surfactants			
Anionic surfactants	5 – 10	5 – 15	10 – 20
Non-ionic surfactants	± 5	5 – 10	1 – 10
Amphoteric surfactants			0 – 2
Builders			
Alkalis			
- sodium carbonate	5 – 30	5 – 25	10 – 50
- sodium silicate	<10	5 – 10	< 5
Ion exchangers			
- zeolite	25 – 35	20 – 40	15 – 60
- polycarboxylate	0 – 5	0 – 5	1 – 5
Complexing agents			
- citric acid/ citrate	0 – 5	0 – 10	0 – 10
- phosphonates	0 – 0.5	0 – 0.5	
Bleaching agents			
Sodium perborate/ percarbonate	5 – 15		
TAED	2 – 6		
Additives			
Optical brighteners	0.1 – 0.2		
Dye transfer inhibitor		0.5 – 2	0.5 – 2
- polyvinylpyrrolidon (PVP)			
Sodium sulfate	< 5	< 5	2 – 40
Enzymes	< 2	< 2	0 – 2
Anti-redeposition agents:	0 – 2	0 – 2	0 – 2
- carboxymethylcellulose (CMC)			
- carboxymethylstarch (CMS)			
Foam inhibitors	0 – 0.1	0 – 0.1	0 – 0.1
Perfume	0 – 1	0 – 1	0 – 1
Dye	0 – 0.1	0 – 0.1	0 – 0.1

For ingredients in detergent powders, see section 1.5.

3.1.1 Machine wash

Charging the washing machine with laundry powder may lead to generation of dust particles and may lead to inhalation exposure (see subsection 2.2.1).

General

- *Frequency*

According to the US EPA[18)], the frequency ranges from 0.22 to 1.90 a day, with a weighted mean of 1.32 a day. The table of the AISE[20)] mentioned in the TGD[11)] gives the frequency of washing with powder laundry products ranging from 1 to 21 times a week. The typical frequency is 5 times a week. The typical frequency is the frequency a consumer generally uses a product. Using the data above, the default value is set at 7 $week^{-1}$ or 365 $year^{-1}$.

Inhalation: vapour, instantaneous release

- *Exposure duration*

The exposure duration includes picking up the package, opening it, filling the machine and closing the package. For the exposure duration, Weegels finds a mean duration of 11 seconds (S.D. 3 s); the calculated 75th percentile is 13.04 s or 0.22 min. (n=10). The exposure duration ranges from 7 to 14 seconds. The AISE[20, 11)] gives a duration of less than 1 minute. Using these data, the default value is set at 15 s or 0.25 min.

Default values for laundry powder: filling the washing machine

	Default value	Q	References, comments
General			
Frequency	365 $year^{-1}$	3	See above
Inhalation			
Exposure, instantaneous release			
Exposure duration	0.25 min	3	See above
Product amount	2.7 * 10^{-7} g	1	Dust; see § 2.2.1
Room volume	1 m^3	1	See § 2.2.1
Ventilation rate	2 hr^{-1}	1	Bathroom[2)]; see § 2.2.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]

3.1.2 Hand wash

During the hand-wash laundry, the diluted laundry liquid comes in direct contact with the skin of hands and of forearms.

Dermal exposure: instant application

- *Exposed area*

The exposed area is the skin surface area of forearms and hands. The latter has a surface area[2)] of 860 cm^2. The Fact Sheet General[2)] gives no default value for the skin area of forearms; the Exposure Factors Handbook[48)] gives for the forearms a percentage of 5.9 % surface area by body part. With a total body surface area[2)] of 17500 cm^2, the skin area for forearms is 1030 cm^2; thus, the total exposed area is 1900 cm^2.

- *Product amount*

It is assumed that not the total amount of *diluted* product is in contact with the skin but only a layer around the exposed skin. The TGD[11)] estimated the thickness of a product layer on the skin at 0.01 cm. The exposed area is 1900 cm^2; thus, the amount of diluted product is 19 cm^3

or 19 g (see section 2.3). The latter is set as default value for the diluted product amount (upon skin).

- *Weight fraction*

According to the AISE[20, 11)], the concentration of laundry detergent for the hand-wash is 0.1 % to 1 %. Worst-case, the weight fraction of the diluted detergent is 1% of the used detergent powder.

Default values for laundry powder: hand washing

	Default value	**Q**	**References, comments**
General			
Frequency	104 $year^{-1}$	3	Estimate: 2 $week^{-1}$
Dermal			
Exposure, instant application			
Exposed area	1900 cm^2	3	Area hands[2)] and forearms
Weight fraction $_{dilution}$	0.01 * W_f	3	See above
Product amount $_{dilution}$	19 g	1	See above
Uptake, diffusion through skin			
Concentration $_{dilution}$	0.01 * W_f g/cm^3	3	Density water 1 g/cm^3 [20)]
Exposure time	10 min	3	

3.1.3 Residues on clothing

After washing, residues of compounds of laundry detergents may remain on clothing and when contacting the skin, residues can migrate from textile to skin. For estimating the dermal exposure, the model 'migration' is used for post-application. Before using this model, the amount of residues must be known. The amount of deposits on fabric depends on the composition of the detergent, the compound in question, the type of textile and on the washing machine that is used.

Few data is available showing how much detergent is deposited on the textile following a wash process. Rodriguez et al.[23)] determined the residues of linear alkylbenzene sulphonate or LAS, which is an anionic surfactant used in laundry detergents. After 10 repeats of a typical washing process with 4 typical laundry products, the deposits of LAS on the fabric were 0.02 g/kg, 0.8 g/kg, 1.5 g/kg and 2.0 g/kg fabric, respectively. They also investigated the amounts of fatty acid salts (FAS) residues which were 0.02 g/kg fabric, 0.4 g/kg and 13.4 g/kg, respectively. Here, it is clearly shown that the amount of compound deposited on the textile depends on the type of chemical and on the product itself. Therefore, extrapolating to the total amount of detergent residues is not feasible.

According to the AISE[20, 11)], the typical amount of washing powder is 75 g per task and the range was from 20 to 200 gram. For 5 kg laundry, the default value for product amount is set at 150 gram per task.
For calculating the amount of residues on the fabric is assumed that 20 % of components of detergents are deposited on the fabric i.e.
150 g powder/ 5 kg g laundry x 0.2 gives 6 g detergent/kg fabric. For the time being, this value is used for estimating the leachable fraction, a parameter in the dermal model

'migration'.

General

- *Frequency*

It is assumed that one wears clothes, e.g. underwear, nightclothes, blouses, trousers and socks, every day during 24 hours.

Dermal exposure: migration

- *Leachable fraction*

The leachable fraction is the relative amount of chemical which can leach from a product (g/g) i.e. the fraction of deposits of the detergent which can leach from textile. The leachable weight fraction depends on the composition of the detergent, the compound in question and the type of textile.
Because there are no data for the amount of detergent residues leaching from the textile, it is assumed that 50% is leachable. The calculation for the leachable weight fraction is as follows: 6×10^{-3} g/g x 0.5 x W_f = 3×10^{-3} x W_f (see above).
In this calculation, the data for the amount of residues on the fabric and for the leaching amount of residues from the fabric are not known; therefore, the quality factor is given a 1.

- *Product amount*

The total weight of fabric i.e. average weight product during the day that is worn on the body is estimated at 1000 gram.

- *Skin contact factor*

For the calculation of the skin-contact factor (i.e. the part of the product that is actually in contact with bare skin) it is assumed that 1/2 of the clothes are in direct contact with the skin (e.g. underwear, F_{skin} =1) and 1/2 contacts on and off the skin (e.g. blouses, F_{skin} = 0.6).
The skin-contact factor then becomes 0.5 x 1 + 0.5 x 0.6 = 0.8.

Default values for laundry powder: residues on clothing

	Default value	**Q**	**References, comments**
General			
Frequency	365 $year^{-1}$	3	See above
Dermal			
Exposure, migration			
Leachable fraction	0.003 * W_f	1	See above
Product amount	1000 g	2	See above
Skin contact factor	0.8	2	See above
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

3.2 Detergent liquids

Composition

General formula of detergent liquids [32)]

Laundry products Liquid	**Heavy duty Detergents %**	**Heavy duty colour Detergents %**	**Light duty Detergents %**
Surfactants			
Anionic surfactants	5 – 25	5 – 25	0 – 25
- soap	5 – 25	5 – 25	0 – 5
Non-ionic surfactants	5 – 30	5 – 30	10 – 20
Builders			
Alkalis			
- sodium carbonate	0 – 1	0 – 1	
Ion exchangers			
- polycarboxylate			0 – 5
Complexing agents			
- citric acid/ citrate	3 – 5	3 – 5	0 – 1
- phosphonates	0 – 1	0 – 1	
Solvents			
Alcohols			
- isopropanol / ethanol	1.5 -10	1.5 -10	0 - 15
Additives			
Thickening agents: polymers	1 – 5	1 – 5	
Optical brighteners	0 – 0.1		
Dye transfer inhibitor:		0 – 1	0 – 1
- polyvinylpyrrolidon (PVP)			
Enzymes	< 2	< 2	0 – 2
Foam inhibitors	0.1	0.1	
Preservative	0.1	0.1	<1
Perfume	0 – 1	0 – 1	0 – 1
Dye	0 – 0.1	0 – 0.1	0 – 0.1
Water	Rest 15 – 40 [17)]	rest	rest 50 – 75 [17)]

For ingredients in detergent liquids, see section 1.5.

3.2.1 Machine wash

General

- *Frequency*

The AISE[20, 11)] gives a typical frequency of 4 times a week and a range from 2.8 to 10 times a week. The default value is set at 7 times a week, which is the same as for laundry detergent powder.

Inhalation: vapour, evaporation from constant surface

- *Exposure duration*

According to the AISE[20, 11)], the duration for filling the washing machine with laundry liquid is less than 1 minute. Weegels[10)] gives an exposure duration for filling the *dish*washer a range from 6 to 45 seconds with a mean of 23 s (S.D. 17s; n =4). The calculated 75th percentile is 34.6 sec or 0.58 min. The maximal duration of 45 s or 0.75 min is set as default value.

- *Application duration*

According to Weegels[10)], the duration of loading polishing liquid for the *dish*washer was 11 seconds (S.D. 8) with a 75th percentile of 16.44 sec. or 0.27 min. (n=4). The use duration ranges from 3 to 18 seconds. For loading polishing liquid in the dishwasher, the consumer pours the product into a small box located at the inside of the front; for loading laundry liquid, it is poured into a bowl and placed on the laundry in the washer drum. It is assumed that the use duration for loading laundry liquid takes more time; therefore, the maximal duration is taken as default value i.e. 0.3 minute.

- *Ventilation rate*

A washing machine is mostly located in the kitchen, in the scullery or in the bathroom. For the kitchen and for the bathroom, the ventilation rate[2)] is 2.5 hr^{-1} and 2 hr^{-1}, respectively. The latter is set as default value.

- *Molecular weight matrix*

The fraction of water is estimated at 20 %; the molecular weight matrix becomes 18 g/mol / 0.2 = 90 g/mol (see subsection 2.2.2).

Default values for laundry liquid: filling the washing machine

	Default value	Q	References, comments
General			
Frequency	365 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See above
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	2 hr^{-1}	1	See above and § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	90 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	I.e. exposure duration

3.2.2 Hand wash

See subsection 3.1.2: detergent powder, hand wash.

3.2.3 Residues on clothing

See subsection 3.1.3: detergent powder, residues on clothing.
For calculating the leachable weight fraction, the amount of liquid detergent must be known. The typical value for laundry heavy duty detergent liquid was 90 gram per task with a range from 40 gram to 140 gram[20)]; for product amount, the default value is set at 115 gram liquid.
The total amount of residues is calculated as follows:
115 g liquid / 5 kg laundry x 0.2 (deposition fraction) = 4.6 g detergent /kg fabric
The leachable weight fraction for a compound is calculated as follows:
0.0046 g liquid/g fabric x 0.5 (leachable fraction) x W_f (weight fraction compound) = $2.3 \times 10^{-3} \times W_f$.

3.3 Fabric conditioners

Composition
General formula of concentrated conditioner[11,32]:

Fabric conditioner	**%**
Surfactants	
Cationic surfactants	< 25
Non-ionic surfactants	0 – 4
Solvents	
Alcohol	0 – 10
Additives	
Preservatives	< 1%
Dye	0 – 0.1 %
Silicones	< 0.5%
Perfume	< 1%
Water	Rest

For ingredients in fabric conditioners, see section 1.5.

3.3.1 Machine wash

See subsection 3.2.1: liquid detergents, machine wash. It is assumed that fabric conditioner is added at the last rinsing cycle of the washing machine.

3.3.2 Residues on clothing

See subsection 3.1.3: detergent powder, residues on clothing.
According to the US EPA[18], the amount of fabric conditioners varied between 10 and 60 gram; the mean was 46.6 gram[18]. The AISE[20, 11] gives for the amount of fabric conditioners a range from 11 to 90 gram per task; the typical amount is 44 gram. For amount, the default value is set at 68 gram.
Presumably the fraction of residues on clothes is higher when one is using fabric conditioner instead of liquid detergent or detergent powder. This is because fabric conditioner is added at the last rinsing cycle of the washing machine. Worst case, it is assumed that 50 % is deposited on the fabric. Further, it is assumed that 50 % of the residues of the fabric conditioners are leachable. The leachable weight fraction is calculated as follows:
$68\ g / 5000\ g \times 0.5 \times 0.5 \times W_f = 3.4 \times 10^{-3} \times W_f$.

3.4 Laundry pre-treatment products

3.4.1 Introduction

Besides detergents, there are other laundry products: laundry aids[4,17]. They contribute to the effectiveness of laundry detergents and provide specific functioning. The laundry aids can be categorized in:

- pre-treatment aids
  - laundry or water conditioners with mainly builders such as polycarboylates (5-15 %) and zeolite (> 30 %)
  - pre-soaking products containing surfactants (10-15 %), builders (80 %), enzymes (< 5 %)

    - pre-wash soil and stain removers with surfactants (5-15 %), enzymes, preservatives
- laundry boosters containing surfactants (< 5 %) and bleaching agents
- after-treatment aids
    - fabric conditioners: see section 3.3
    - starches (corn, potato, rice or wheat starch) and stiffeners (synthetic polymers)
    - fabric formers: stiffener based on a copolymer of polyvinylacetate with an unsaturated organic acid; additives such as polywax
- laundry dryer aids: sheets impregnated with conditioners

Defaults are given for the pre-wash soil and stain removers. For treating stains on textile, consumers use laundry liquids/ sprays or detergent pastes which are applied directly on the garment. In this chapter the following products are discussed: spray spot removers, liquid spot removers and pastes.

3.4.2 Spray spot removers

Using a spray spot remover, the user can be exposed to aerosols. To calculate the exposure of the user during spraying, the 'spray model' is used for inhalation exposure and the model 'constant rate' for dermal exposure.
When treating the stains on the garments, there can also be direct skin contact with the product; to calculate dermal exposure, the model 'instant application' is used.
In the scenario the use of a trigger spray is described. Generally, consumers pre-wet the laundry before applying the detergent or they use the stain remover under running tap water. As dilution a factor of 10 times is used.

General

- *Frequency*

The US EPA[18)] gives frequency values for laundry boosters (pre-soaks and pre-cleaners). The range is from 0.06 to 0.82 a day, with a weighted mean of 0.35 a day. Using this data, the frequency of laundry pre-treatment is set at 128 year^{-1}.

Phase 1 application: spraying

Inhalation: spray model

- *Spray duration*

The default value for the mass generation rate of a spray is 1.5 g/sec (see subsection 2.4.1). For spray spot remover, the used amount was 3.9 gram per task[18)]. Using this data, it is calculated, that the period of active spraying is 3.9 g / 1.5 g/s = 2.6 seconds. The default value for spray duration is set at 3 seconds or 0.05 min.

- *Exposure duration*

The AISE[20, 11)] gives 10 min. per task for the use of laundry-pre-treatment. This value is set as default value use for the exposure duration.

- *Weight fraction non-volatile*

Pre-wash soil and stain removers contain 5-15 % surfactants (see subsection 3.4.1). Based on the general composition, it is assumed that the non-volatile part in spray spot removers is about 10%; the default value weight fraction non-volatile is set at 0.1 g/g.

Default values for spray spot remover: spraying

	Default value	Q	References, comments
General			
Frequency	128 year^{-1}	3	See above
Inhalation			
Exposure, spray model			
Spray duration	0.05 min	3	See above
Exposure duration	10 min	3	See above
Room volume	10 m^3	3	Bathroom[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	2 hr^{-1}	3	Bathroom[2)]
Mass generation rate	1.5 g/ sec	3	See § 2.4.1
Airborne fraction	0.2 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.1 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	46 mg/min	3	See § 2.4.2
Release duration	0.05 min	3	I.e. spray duration
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

Phase 2 application: washing

Dermal exposure: instant application

- *Exposed area*

Only a fraction of the hands is exposed to the diluted product. Here, half of the hand area is taken i.e. 0.5 x 860 cm^2 [(2)] = 430 cm^2.

- *Product amount*

For spray spot removers, the amount per task is 3.9 gram[18)]. For estimating dermal exposure, it is assumed that 5 % of the amount contacts the skin, i.e. 0.2 g. Taken the dilution into account (10 times), the default value for the diluted product amount is set at 2.0 g.

Default values for spray spot remover: washing

	Default value	Q	References, comments
General			
Frequency	128 year^{-1}	3	See above
Dermal			
Exposure, instant application			
Exposed area	430 cm^2	3	0.5 area hands[2)]
Weight fraction $_{dilution}$	0.1 * W_f	1	Dilution 10x
Product amount $_{dilution}$	2.0 g	1	See above
Uptake, diffusion through skin			
Concentration $_{dilution}$	0.1 * W_f g/cm^3	1	Density water 1 g/cm^3
Exposure time	10 min	3	[20)]

3.4.3 Liquid spot removers

For the scenario 'removing spots on laundry', a special liquid spot remover (or regular laundry liquid) is put on the fabric. Generally, consumers pre-wet the laundry before applying the detergent or they use the stain remover under running tap water. When putting on the spot remover and treating the stains on garments, there can be direct skin contact with the (diluted) product; to calculate dermal exposure, the model 'instant application' is used. As dilution a factor of 10 times is used.

Dermal exposure: instant application

- *Product amount*

For liquid spot removers, the amount per task is 1.3 gram[18)]. Assuming that 5 % contacts the skin and taking the dilution of 10 times into account, the default value is set at 0.65 g diluted product.

Default values for liquid spot remover

	Default value	Q	References, comments
General			
Frequency	128 year^{-1}	3	See § 3.4.2
Dermal			
Exposure, instant application			
Exposed area	430 cm^2	3	0.5 area hands[2)]
Weight fraction $_{dilution}$	0.1 * W_f	1	Dilution 10x; see § 3.4.2
Product amount $_{dilution}$	0.65 g	1	See above
Uptake, diffusion through skin			
Concentration $_{dilution}$	0.1 * W_f g/cm^3	1	Density water 1 g/cm^3
Exposure time	10 min	3	[20)]

3.4.4 Pastes

Detergent paste (tube) contains water and laundry powder in the proportion of one to one[20]. It has the same dermal scenario as liquid spot removers (see subsection 3.4.3); for the parameters, see subsection 3.4.2.

Dermal exposure: instant application

- *Product amount*

According to the US EPA[18], the amount of powdered pre-soak per task was 5 gram. The default value is 5 % of 5 gram i.e. 0.25 g. Assuming that 5 % contacts the skin and taking the dilution of 10 times into account, the default value is set at 2.5 g diluted product. For the other default values: see subsection 3.4.2.

4 Dish washing products

4.1 Hand dishwashing liquids

4.1.1 Introduction

Use

The cleaning ability of manual dishwashing products is based on surface-active substances. The pH of these detergents ranges between 5.5 and 8.5. The important properties of the detergents are:

- foaming power:
  this fulfils an aesthetic function, there is no close relation between foaming power and cleaning capacity
- cleaning capacity:
  good wetting of hydrophobic and hydrophilic surfaces
  enhancement of dirt removal
  stable dispersion of removed dirt
- clear drying properties:
  easy flow-off on hard surfaces (hydrophilic runoff)
  residue free drying, independent of the water composition

The food residues on the crockery are removed by washing them in water with dishwashing detergent. Usually, the dirt is removed with a brush. Scourers are used to clear away the heavier food residues. Lastly, the cleaned items are dried either with a towel or by placing them in a dish drainer.
The results of the dishwashing depend on:

- the temperature of the dishwashing water
- the water quality: major surfactant combination often perform better in hard water than in soft water
- type of soil and adhesive strength of the residue to the surface (condition, material properties)
- surfactant concentration in relation to the amount of food residue per plate: the dishwashing performance is not linearly related to the surfactant concentration

Dishwashing products are also used for other cleaning tasks in the household or for washing the hands or textiles (non-intended uses).
The text above is derived from Falbe[4)].

Composition

General formula of liquid hand dishwashing detergent [4,17,32)]

Hand dishwashing detergent	Liquid %
Surfactants	
Anionic surfactants	10 – 30
Non-ionic surfactants	0 – 20
Amphoteric surfactants	0 – 5
Solvents	
Alcohol: isopropanol/ ethanol	0 – 10
Additives	
Sodium citrate	0 – 2
Skin protecting agents	< 2
Preservatives	0 – 1
Dye	< 0.1
Perfume	< 0.5
Water	45 - 80

For ingredients in hand dishwashing detergents, see section 1.5.

4.1.2 Mixing and loading dishwashing liquid

The exposure of a cleaner liquid during mixing and loading is described in subsection 2.2.2 and subsection 2.2.3.

General

- *Frequency*

The range given by the AISE[20, 11)] is from 3 to 21 times a week, with a typical frequency of 14 times a week. Weegels[10)] found a frequency of doing the dishes of 0.63 per day (standard deviation (S.D.) = 0.79) with a 75-percentile of 1.17 day per day (n=45), which results in a frequency of 426 per year. The latter is used as default value for frequency.

Inhalation: vapour, evaporation from constant surface

- *Molecular weight matrix*

Assuming the product contains 50 % water, the molecular weight matrix is
18 g/mol / 0.5 = 36 g/mol (see subsection 2.2.2).

Default values for dishwashing liquid: mixing and loading

	Default value	Q	References, comments
General			
Frequency	426 year^{-1}	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See § 3.2.1
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	2.5 h^{-1}	1	Kitchen[2)]; see § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See § 3.2.1
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	36 g/ mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: ¼ area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	I.e. exposure duration

4.1.3 Dishwashing

When doing the dishes, there is dermal exposure to the diluted dishwashing liquid. Inhalation exposure occurs due to compounds, which evaporate from the dishwashing water.

Inhalation: vapour, evaporation from constant surface

- *Exposure duration*

The exposure duration of inhalation exposure is the time of being in the kitchen, which is estimated at 60 min.

- *Application duration*

The duration of task given by the AISE[20, 11)] ranges from 10 to 45 minutes with a typical duration of 30 minutes. Weegels[10)] measured the duration of dermal contact with dishwashing water, including cleaning tasks after doing the dishes; the time needed for drying was excluded. The duration of contact per event was 11 min (S.D. 7) with a 75th percentile of 16 min (n=592), which is set as default value for application duration (inhalation exposure) and for exposure time (dermal exposure).

- *Release area*

When doing the dishes, the release area equals the surface of the sink. The average area of

18 sinks was 1434 cm^2 (S.D. 57)[12]. For the release area, the 75th percentile of the surface of the sinks was calculated as 1453 cm^2 [12]. The default value is set at 0.15 m^2.

- *Product amount*

This parameter is to limit the evaporated amount of compound from the product. The amount is calculated by multiplying the release area of 1500 cm^2 with a water height of about 10 cm resulting in an amount of 15000 cm^3 water i.e. 15000 gram.

- *Temperature*

Initially, the temperature of the dishwater is high, approximately 60 ˚C and while doing the dishes, the temperature will decrease. The most frequently used dishwashing temperatures are in the range of 40-45 ˚C [4]. Therefore, the default value for the 'average' temperature is estimated at 45 ˚C.

- *Weight fraction*

For the amount of dishwashing liquid, Weegels[10] gives 5 gram per event (S.D. 3) with a 75th percentile of 7.0 g (n=163). The values of the AISE[20, 11] for liquid regular varies from 3 to 10 gram (per 5 litres wash water volume); for liquid concentrate the range is from 2 to 5 gram (per 5 l). The 75th percentile found by Weegels is used as default value for liquid regular, i.e. 7 gram (per 5 litres). This gives a concentration of 1.4 g/l.
The fraction in the washing-up bowl is 7 g / 5000 g = 1.4×10^{-3} of the dishwashing product. This means a dilution of about 714 times; the weight fraction of the solution is the weight fraction of the product divided by the dilution factor (W_f / 714).

Default values for dishwashing liquid regular: hand-wash

	Default value	Q	References, comments
General			
Frequency	426 $year^{-1}$	3	See § 4.1.2
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	60 min	3	See above
Product amount $_{dilution}$	15000 g	3	See above
Weight fraction $_{dilution}$	W_f / 714	3	See above
Room volume	15 m^3	4	Kitchen[2)]
Ventilation rate	2.5 h^{-1}	3	Kitchen[2)]
Release area	0.15 m^2	3	See above
Application duration	16 min	3	See above
Temperature	45° C	3	See above
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/ mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	860 cm^2	3	Area hands[2)]
Weight fraction $_{dilution}$	W_f / 714	3	See above
Product amount $_{dilution}$	8.6 g	1	Skin layer: 0.01 cm[11)]; see § 2.3
Uptake, diffusion through skin			
Concentration $_{dilution}$	W_f / 714 g/cm^3	3	Density water 1 g/cm^3
Exposure time	16 min	3	I.e. application duration

4.1.4 Residues on dinnerware

Oral exposure can occur because of residues on washed dinnerware. The quantity depends on the concentration of the detergent and on the washing-up temperature. The residue quantity increases with the detergent concentration or with the dishwaters temperature. Not drying the dinnerware results in a higher amount of residue on the dishes and glassware[12)]. A scenario is described in which all the dinnerware is not dried with a dishcloth.

General

- *Frequency*

It is assumed that every day dinnerware is used for food and drinks.

Oral exposure: direct intake

- *Amount ingested*

According to HERA[24)], the value for amount of water left on dishes is 5.5 x 10^{-5} ml/cm^2 and the value for the area of dishes in daily contact with food is 5400 cm^2. The concentration of the dishwashing water is 1.4 g/l (see subsection 4.1.3).

Using these data, the ingested product amount is
5.5 x 10^{-5} ml/ cm^2 x 5400 cm^2 x 1.4 mg/ml = 0.4158 mg.

Default values for dishwashing liquid: residues on dinnerware

	Default value	Q	References, comments
General			
Frequency	365 $year^{-1}$	4	See above
Oral			
Exposure, direct intake			
Amount ingested	4.2 * 10^{-4} g	2	See above
Uptake			
Uptake fraction	1	2	Potential dose

4.2 Machine dishwashing products

4.2.1 Introduction

Use

The program of the dishwashing machines consists of several partial steps. For each step, fresh water is needed. Besides detergent and rinsing aid, salt is necessary for pre-softening hard water.
In the pre-wash cycle, food residues are removed by pure water. This is followed by the wash cycle in which an (alkaline) dishwashing detergent is added. After one to two intermittent rinse steps, the final rinse cycle follows during which a rinse aid is generally added. Finally, the cleaned items are dried in the drying step. After ending the dishwashing program, the dinnerware should be practically free of rinse aid or detergent residues.
The text above is derived from Falbe[4)].

4.2.2 Dishwashing powders

Dishwashing powders contain non-ionic surfactants as cleaning agent. The criteria for non-ionic surfactants in machine dishwashing detergents are[4)]:

- low foam at the temperature range from start temperature to the highest temperature (circa 65 °C)
- good stability against e.g. alkalis and ingredients which form active chlorine
- support of the dissolving rate of other ingredients
- wetting of the soiled items
- principle improvement of all cleaning processes

For granules, it is assumed that a maximum of 10 % is present in the form of powder[37)]. The inhalation exposure is therefore expected to be 10-fold lower than the exposure of a powder. There also are tablets containing all the different substances i.e. detergent, rinse aid and salt. For tablets, the inhalation and dermal exposure is considered to be negligible; therefore, there are no defaults given for tablets. The exposure of loading salt is not regarded and there are no defaults given.

Composition

General formula of machine dishwash detergent

Machine dishwash detergent	**Powder**[17] **%**	**Tablet**[32] **%**	**All-in-one**[32] **%**	**Salt**[32] **%**
Surfactants				
Non-ionic surfactants	1 – 5	< 5	< 5	
Builders	45 – 70			
Alkalis				
- sodium carbonate		0 - 40	0 – 35	
- sodium silicate		0 - 15	0 – 15	
Ion exchangers				
- polycarboxylate		< 5	< 5	
- sodium chloride				> 98
Complexing agents				
- phosphates		0 – 45	0 – 70	
- phosphonates		< 5	< 5	
Bleaching agents				
Sodium perborate/ percarbonate	5 – 10	15 – 40	5 – 15	
TAED	1 – 2		0 – 5	
Alkalis	5 - > 30			
Sodium metasilicate				
Sodium disilicate				
Additives				
Sodium sulphate	1		0 – 40	
Enzymes	1 – 3	0 - 10	0 – 5	
Dye	< 1	< 1	< 1	
Perfume	< 1	< 1	< 1	

For ingredients in dishwashing powders, see section 1.5.

Inhalation: vapour, instantaneous release

Except for frequency, the default values for dishwashing detergents correspond to those for detergent powders used for machine wash (see subsection 3.1.1).
Weegels[10] gives the frequency of filling the dishwashing machine with powder or tablets. This was 0.35 per day (S.D. 0.50; n=107) with a 75th percentile of 0.69 day^{-1} or 252 year^{-1}. This value is set as default value (Q=3). The ventilation rate of the kitchen is 2.5 hr^{-1} [(2)].

Oral exposure: direct intake

Because the crockery is rinsed with clean water, the amount of residues on dinnerware is much smaller than with hand-wash, without drying with a dishcloth. The quantity is assumed to be 20 % of the ingested product amount left on dinnerware by hand washing i.e.
0.2 x 4.2 x 10^{-4} g = 8.4 x 10^{-5} g (Q = 1).

4.2.3 Liquids: rinse aids

These rinsing agents reduce the surface tension between the washed items and water during the final rinse cycle. By achieving a uniformly draining film, there is a good clear drying effect and there are no spots, stains and streaks left behind on the tableware.

Composition

General formula of machine dishwash: liquids, rinse aid[17,32)]

Machine dishwash, rinse aid	**Liquid %**
Surfactants	
Non-ionic surfactants	5 – 15
Builders	0 – 15
Citric acid	
Hydrotopes (solubilizers)	5 – 15
Sodium cumeensulphonate	
Sodium xyleensulphonate	
Isopropanol/ ethanol	0 – 5
Additives	
Preservatives	< 1
Dye	< 0.1
Perfume	< 1
Water	50 - 65

For ingredients in rinse liquids, see section 1.5.

General

- *Frequency*

For estimating the frequency of filling the machine with polishing liquid, Weegels[10)] notices that during the three weeks (diary period) two persons had not use the liquid, two persons had used it once and three persons twice. As default value, it is assumed that the use is 2 times per 3 weeks i.e. 35 year^{-1}.

Inhalation: vapour, evaporation from constant surface

- *Molecular weight fraction*

The fraction of water in polishing liquid is estimated at 0.3; so, the molecular weight fraction is 18 g/mol / 0.3 = 60 g/mol (see subsection 2.2.2).

Default values for liquid, rinse aid: filling the dishwashing machine

	Default value	Q	References, comments
General			
Frequency	35 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See § 3.2.1
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	2.5 hr^{-1}	1	Kitchen[2)]; see § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See § 3.2.1
Temperature	20 ^0C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	60 g/ mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	See § 3.2.1

5 All-purpose cleaners

5.1 Introduction

All-purpose cleaners can be used for cleaning hard surfaces like windows, mirrors, wood, floors and tiled walls. They are used for different purposes in and around the house. Because the types of soil and the sorts of surfaces differ, there are all kinds of all-purpose cleaners: regular, concentrated, liquid soft soap and acid cleaners; the last can remove scale. There is no universal cleaner in particular that can handle all cleaning objectives and their soil. The demands of the consumer on all-purpose cleaners are:

- high cleaning performance
- surface protection
- residue free drying of the clean surface
- good skin compatibility
- easy handling/ dosage
- appropriate foaming behaviour
- pleasant odour during and after cleaning

For manual cleaning surfaces with an all-purpose cleaner, one uses a sponge, cloth or mop. The cleaner can be used diluted; if there is localized persistent soil, it can be used in the undiluted form. In this case, it is necessary to wipe off or to rinse off the remainder of the cleaning agents. The chemical composition of all-purpose cleaner determines mainly the removal of stains; in scouring agents, abrasives enhance the mechanical contribution for the cleaning effect.
The text above is derived from Falbe[4)].

All-purpose cleaners are offered as liquids, they are also available as trigger sprays or as tissues. The applications of these products are described in this chapter: liquid cleaners in section 5.2, spray cleaners in section 5.3 and tissues in section 5.4.
This chapter deals with all purpose cleaners, abrasives are described in chapter 6. All-purpose cleaners are also used for cleaning the floor. In chapter 8, the default values of floor care products can be found.

Composition
These rinsing agents reduce the surface tension between the washed items and water during the final rinse cycle. By achieving a uniformly draining film, there is a good clear drying effect and there are no spots, stains and streaks left behind on the tableware.
Kitchen cleaners contain more surfactants (5-30 %) and more alkalis (1-35 %), such as ammonia, caustic soda or caustic potash. This is necessary for removing all kinds of dirt and grease[5)].
Like the all-purpose liquids, sprays and wet tissues are formulated with surfactants and low levels of builders; most contain an organic solvent.

General formula of all-purpose cleaner

All-purpose cleaner	Liquid[4,11,17)] %	Spray[a)] %	Wet tissues[27)*] %
Surfactants		0 – 15	< 10
Anionic surfactants	2 – 10		
Soap	0.5 – 3		
Non-ionic surfactants	0 – 5		
Builders	1 – 10		+
Bases (ammonia)		0 – 5	
Sodium carbonate			
Sodium citrate			
Solvents & hydrotropes	0 - 15	2 – 15	< 10
Solvents: alcohol, glycol	0 – 10		
Hydrotropes	0 – 10		
Additives			
Organic polymers	< 2		
Skin protecting agents	< 2		
Preservatives	< 1	< 1	< 1
Dye	< 1	< 1	
Perfume	< 1	< 1	< 1
Water	75 – 85	85 - 95	70 - 95

+: ingredient of wet tissues
a): information from the Dutch Association for Soap Manufacturers (NVZ), January 2004
*: for the wet fraction of tissues (circa 60 % of total weight[12)]), the percentages of the ingredients are given

For ingredients in all-purpose cleaners, see section 1.5.

5.2 Liquid cleaners

Use

From 'Exposure to chemicals in consumer product use[10)], is derived that most people use an all-purpose cleaner for cleaning furniture as well as for cleaning floors. All-purpose cleaner is most frequently used for cleaning furniture and cleaning the toilet. Most of the time, an all-purpose cleaner is used in bathroom, toilet and kitchen.
The scenario describes the cleaning of 10 m^2 furniture such as tables and cupboards in the living room. Liquid cleaner, 63 gram, is diluted in a bucket with 5 litres water. Exposure can occur during mixing and loading, and during cleaning.

Mixing and loading

General

- *Frequency*

The AISE[20, 11)] gives for *surface* cleaners a typical use of 2 times a week and a range from 1 to 7 times a week. Weegels[10)] gives an average frequency per day of 0.4 (S.D. 0.7), which results in a 75 percentile of 0.88 day^{-1} or 320 $year^{-1}$ (n=28). This value included also cleaning the floor, bathroom etc.; therefore, the typical value of the AISE is used as default value for

cleaning furniture i.e. 104 year^{-1}.

Inhalation: vapour, evaporation from constant surface

- *Molecular weight matrix*

The fraction of water in the product is estimated at 0.8. For the molecular weight matrix, the default value is 18 g/mol / 0.8 = 22 g/mol (see subsection 2.2.2).

Default values for all-purpose cleaner liquid: mixing and loading

	Default value	**Q**	**References, comments**
General			
Frequency	104 year^{-1}	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See § 3.2.1
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	0.5 hr^{-1}	1	Living room[2)]; see § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See § 3.2.1
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	See § 3.2.1

Cleaning

Inhalation: vapour, evaporation from increasing area

- *Application duration*

According to the AISE[20, 11)], the duration of task is 10 to 20 minutes. The average duration of all-purpose cleaner use per instance, found by Weegels[10)], is 20 minutes (S.D.= 22; n=204) [10)] with a 75th percentile of 35 minutes. For cleaning the furniture, the default value for application duration is set at 20 minutes.

- *Product amount*

In a limited experiment 40 ml suds was spread on a surface of 1 m^2. The area was quite soaked; therefore, it is assumed that the amount left on the surface is not exceeding 40 ml per m^2. The amount of suds for an area of 10 m^2 is set at 400 ml or 400 g.

- *Weight fraction*

The AISE[20, 11)] gives a typical amount per task of 60 gram per 5 l of wash water volume (range from 30 to 110 gram). Falbe[4)] gives a concentration range of 0.5-2 % i.e. 25 - 100 g in 5 litres water. According to Weegels[10)], the concentration of the diluted all-purpose cleaner is 9.1 g/l (S.D. 5.1; n=20)[10)] with a 75th percentile of 12.6 g/l. Per 5 litres wash water volume, 63 g all-purpose liquid is used, which gives a dilution of 80 times. The weight fraction of the suds is the weight fraction of the product divided by the dilution factor (W_f/ 80).

Default values for all-purpose cleaners: cleaning furniture

	Default value	**Q**	**References, comments**
General			
Frequency	104 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	240 min	3	Default
Product amount $_{dilution}$	400 g	2	See above
Weight fraction $_{dilution}$	W_f / 80	3	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Release area	10 m^2	2	See above
Application duration	20 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/ mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			See § 3.1.2
Exposed area	1900 cm^2	3	Area hands[2)] and forearms
Weight fraction $_{dilution}$	W_f / 80	3	See above
Product amount $_{dilution}$	19 g	1	Skin layer 0.01 cm[11)]: see § 2.3
Uptake, diffusion through skin			
Concentration $_{dilution}$	W_f /80 g/cm^3	3	Density water 1 g/cm^3
Exposure time	20 min	2	I.e. application duration

5.3 Spray cleaners

Use
Spray cleaners are suitable for cleaning all washable surfaces and they are designed for use on smaller washable areas. Here, the scenario deals with a trigger spray which is used once a day for cleaning the kitchen working top with an area of 1.71 m^2 [12)]. During the use of cleaning sprays, three phases can be distinguished. First, the product is sprayed onto the surface; then, it is left on the surface to soak in for several minutes; finally, the surface should be rinsed or taken off with a wet cloth.
Cleaning kitchen working top
When using a trigger spray for cleaning such as the kitchen working top, the scenarios for modelling inhalation exposure vary among the different use phases. For spraying, the first phase, to calculate the exposure to aerosol particles the spray model is used for inhalation exposure and the model 'constant rate' for dermal exposure.
During leaving on and cleaning, (slightly) volatile compounds evaporate from the product, which is sprayed on the surface. To this end the model 'evaporation from a constant surface' is used. During cleaning the surface, dermal exposure could occur which is calculated with the model 'instant application'.

Phase 1 application: spraying

Inhalation: spray model

- *Spray duration*

The calculated 75th percentile for the spraying is derived from Weerdesteijn et al.'s data[12)] (14.3 sec. per m^2; see subsection 2.4.1). For an area of 1.71 m^2, the spraying time is 0.41 min (24.5 sec), which is set as default value.

- *Weight fraction non-volatile*

Based on the general composition, it is assumed that the non-volatile part in all-purpose spray cleaners is about 5 %; the default value weight fraction non-volatile is set at 0.05 g/g.

Default values all-purpose spray cleaner: spraying the kitchen working top

	Default value	Q	References, comments
General			
Frequency	365 year^{-1}	2	Estimate: 1 day^{-1}
Inhalation			
Exposure, spray model			
Spray duration	0.41 min	3	See above
Exposure duration	60 min	3	Estimate
Room volume	15 m^3	4	Kitchen[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	2.5 hr^{-1}	3	Kitchen[2)]
Mass generation rate	0.78 g/ sec	3	See § 2.4.1
Airborne fraction	0.2 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.05 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	46 mg/ min	3	See § 2.4.2
Release duration	0.41 min	3	I.e. spray duration
Uptake			
Uptake fraction	1	2	Potential dose

Phase 2 and 3 application: leaving on and cleaning

Inhalation: vapour, evaporation from constant surface

- *Application duration*

The application duration is the time that the compound evaporates from the kitchen working top. The application duration includes the spray duration, the 'leaving on' time and the cleaning time. The spray duration is 0.41 min (see above); the calculated 75th percentiles for the cleaning time are derived from Weerdesteijn et al.[12)] data (110 sec. per m^2; see subsection 2.4.1). For an area of 1.71 m^2, the cleaning time is 3.2 min; the value for 'leaving on time' is 5 minutes. Based on these values the application duration is estimated at 10 min.

- *Product amount*

The 75th percentile of the used amount is 4.016 g[12)] per 0.36 m^2; thus, the amount for an area of 1.71 m^2 is 19.1 g. The amount on the surface that evaporates into the room is estimated at 85% of 19.1 g i.e. 16.2 gram, which is set as default value for product amount.

- *Molecular weight matrix*

Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol (see subsection 2.2.2).

Dermal uptake: diffusion through skin

- *Exposure time*

Dermal exposure occurs during cleaning and the exposure time is set at 3.2 min.

Default values all-purpose spray cleaner: leaving on and cleaning the kitchen working top

	Default value	Q	References, comments
General			
Frequency	365 year^{-1}	2	Estimate: 1 day^{-1}
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	60 min	3	Estimate
Product amount	16.2 g	2	See above
Room volume	15 m^3	4	Kitchen[2)]
Ventilation rate	2.5 hr^{-1}	3	Kitchen[2)]
Release area	1.71 m^2	3	See above
Application duration	10 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/ mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.16 g	1	1% of 16.2 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	3.2 min	3	See above

5.4 Wet tissues

Use

Tissues can be used for cleaning all washable surfaces. These solid, moist cleaning tissues are ready for use when taken from the package and they are suitable for single use. After wiping the surface, it is not necessary to rinse the surface and the tissues are thrown away. Tissues can be used for cleaning windows, mirrors or other surfaces; there are also tissues to clean the floor. The scenario describes the cleaning a surface of 2 m^2 by hand once a day, in a non specified room.

Inhalation: vapour, evaporation from increasing area

- *Product amount*

For the determination of the amount of cleaning product in hygienic cleaning tissues, Weerdesteijn et al.[12)] weighted five tissues. This occurred before and after drying the tissues in a stove with a temperature of 100 ˚C. The average wet fraction of the tissues equalled 3.37 gram (S.D. 0.077; n=5) with a 75th percentile of 3.42 gram, which is the default value for product amount.

- *Molecular weight matrix*

Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol (see section 2.2.2).

Dermal exposure: instant application

- *Product amount*

When firmly touching the wet tissue, 0.044 g (S.D. 0.004, n=5)[12)] remained on the surface of the inner hand area. This gives a 75th percentile of 0.047 g, which is about 1.4 % of the total average liquid fraction of the tissues. For amount, the default value is set at 0.047 gram.

Default values for wet tissues: cleaning

	Default value	**Q**	**References, comments**
General			
Frequency	365 year^{-1}	2	Estimate: 1 day^{-1}
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	60 min	3	Estimate
Product amount	3.42 g	3	See above
Room volume	20 m^3	3	Non-specified room[2)]
Ventilation rate	0.6 h^{-1}	3	Non-specified room[2)]
Release area	2 m^2	2	Estimate
Application duration	2 min	2	Estimate
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/ mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.047 g	3	See above
Uptake, diffusion through skin			
Exposure time	2 min	2	I.e. application duration

6 Abrasives

Abrasive cleaners are used to remove soil which is firmly attached to the surface. In these products, small particles of minerals take care for the scouring effect, the surfactants keep the soil in solution and the added bases can remove greasy dirt. The surfaces treated by abrasives must be rinsed with water.
Abrasive cleaning products can be divided into abrasive powders, which must be used with water, abrasive liquids and scouring pads. Mostly, scouring pads are a ball of fine steel wire which provides the scouring action; further, they can contain a cleaning mixture, mainly soap. The use of scouring pads is not described.

Composition

General formula of abrasives:

Abrasives	**Liquid A** *17, 27,31,a)*	**Liquid B** *17, 27,31,a)*	**Powder**[4)]
	%	**%**	**%**
Surfactants			
Anionic surfactants	1 – 10	1 – 10	1-5
Non-ionic surfactants	1 – 10	1 – 10	
Abrasives			
Calcium carbonate	10 – 50		
Calcium-magnesium carbonate			90 – 100
Alkaline salts/ bases	1 – 5		5 – 10
Aluminium oxide/ silica		10 – 40	
Acid salts/ acids		1 – 10	
Builders	0 – 10	0 – 10	
Solvents & hydrotropes	0 – 5	0 – 5	
Additives			
Bleaching agents	0 – 2	0 – 2	
Organic polymers	< 2	< 2	
Skin protecting agents	< 2	< 2	
Preservatives	< 1	< 1	
Dye	< 1	< 1	
Perfume	< 1	< 1	
Water	40 – 60	40 – 60	

a): information from the Dutch Association for Soap Manufacturers (NVZ), January 2004
For ingredients in abrasives, see section 1.5.

6.1 Abrasive liquids

Abrasive liquids are a suspension of solid abrasive particles in a viscous liquid matrix. Relatively softer minerals in abrasives like calcium carbonate are utilized for abrasive liquids compared with abrasive powders; so, their scouring effect is generally gentler than powders. Liquids especially for cleaning ceramic cooking rings contain surfactants and abrasives (metal oxides e.g. Al_2O_3)

Use
According to Weegels[10] abrasives were most often used for the lavatory pan, followed by the washbasins and kitchen sink/ working top. The scenario describes the cleaning of the lavatory pan, washbasin and floor in the toilet.

General

- *Frequency*

Weegels[10] gives an average frequency for the total use of abrasives of 0.4 per day (S.D. 0.6; n=12) with a 75th percentile of 0.81 day^{-1} or 295 year^{-1}. The AISE[20, 11] gives for surface cleaners (all-purpose cleaner and abrasive) a typical usage of 2 times a week and a range from 1 to 7 times a week. The default value for frequency of cleaning the toilet is set at 3 times per week or 156 times per year.

Inhalation: vapour, evaporation from increasing area

- *Application duration*

According to the AISE[20, 11], the duration of the use of surface cleaners is 10 to 20 minutes. Weegels[10] found an average duration for abrasive usage per instance of 7 minutes (S.D. 8; n=87), which gives a 75th percentile of 12.4 minutes. For the large cleaning of the toilet (the interior and exterior of the toilet pan plus floor, basin, tiles and various attributes), Weegels[10] gives an average duration of 366 sec (S.D.=134) which results in a 75th percentile of 457 sec or 7.6 min. The default value for cleaning the toilet with abrasives is set at 7.6 min.

- *Product amount*

One subject in the pilot study of Weegels weighted the amount of abrasive used per event, which was average 24 gram (S.D. 19; n=12)[10] with a 75th percentile of 36.9 g. For surface cleaners, powders, the AISE gives a range from 20 to 40 gram. As default value, 37 gram is taken.

- *Molecular weight matrix*

Assuming that the water fraction is 0.4, the molecular weight matrix is 45 g/mol (see subsection 2.2.2).

Default values for liquid abrasives: cleaning

	Default value	Q	References, comments
General			
Frequency	156 year^{-1}	3	See above
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	10 min	2	Estimate
Product amount	37 g	3	See above
Room volume	2.5 m^3	3	Toilet[2)]
Ventilation rate	2 h^{-1}	3	Toilet[2)]
Release area	4 m^2	2	Estimate
Application duration	7.6 min	3	See above
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	45 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.37 g	1	1 % of 37 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	7.6 min	3	I.e. application duration

6.2 Abrasive powders

Use

When using powders such as abrasive powders, inhalation/ oral exposure can occur to particles which whirl around in the air. No special model, developed for the application, is available for the use of powders. The use of powders can be described with the help of the 'spray model', which is developed for the spraying of (liquid) aerosols. The definitions for a number of parameters do have to be somewhat altered. The spray cloud model describes the behaviour of a cloud of aerosol particles, but it can also describe a cloud of solid particles, that is, a scattered powder.

As scenario, the cleaning of the kitchen working top and of the gas stove is described. The default value for the total area is set at 2 m^2, derived from 1.71 m^2 of the kitchen working top plus 0.36 m^2 of the gas stove.

General

- *Frequency*

The AISE[20, 11)] gives for surface cleaners (all-purpose cleaner and abrasive) a typical usage of 2 times a week and a range from 1 to 7 times a week. Weegels[10)] gives an average frequency for the total use of abrasives (powder and liquid) of 0.4 per day (S.D 0.6; n=12) with a

75th percentile of 0.81 day^{-1} or 295 year^{-1}. For frequency of cleaning the kitchen working top and gas stove with abrasive powder, the default value is set at two times a week or 104 year^{-1}.

Inhalation: spray model

- *'Spray' duration*

For the scattering of powder on the kitchen working top and gas stove, the 'spray' duration is estimated at 1 min.

- *Mass generation rate*

The default value for amount is set at 37 gram (see section 6.1). The mass generation rate is calculated as follows: 37 gram / 60 sec = 0.62 g/s, which is set as default value.

- *Initial particle distribution*

In the TNsG's[41] a 'Consumer product spraying and dusting' model is stated 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) [41].
Based on this data, the default value for the initial partial distribution is a lognormal distribution with a median of 75 µm and a coefficient of variation of 0.6. To what extent this value is applicable to the 'initial particle distribution' is unknown; considering the use of abrasive powder the particles are presumably larger than 75 µm and the given default values for the initial particle distribution reflect a worst-case assumption. The quality factor is set at 1.

Dermal exposure: constant rate

- *Contact rate*

In the above-mentioned dusting model (TNsG[41]), the subjects in the study applied crack and crevice powders in a kitchen. The dermal exposure on hands and forearms ranges from 0.4 to 4.18 mg/min with a 75th percentile of 2.83 mg/min. The dermal exposure for legs, feet and face ranges from 0.22 to 6.56 mg/min with a 75th percentile of 2.15 mg/min. Using these data, the default value for contact rate is set at 5.0 mg/minute. To what extent this value is applicable to the 'contact rate' of abrasive powder is unknown, therefore the quality factor is set at 1.

Default values for abrasive powders: scattering

	Default value	Q	References, comments
General			
Frequency	104 $year^{-1}$	3	See above
Inhalation			
Exposure, spray model			
Spray duration	1 min	2	See above
Exposure duration	60 min	3	Estimate
Room volume	15 m^3	4	Kitchen[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	2.5 hr^{-1}	3	Kitchen[2)]
Mass generation rate	0.62 g/sec	2	See above
Airborne fraction	0.2	1	No available data; see § 2.4.1
Weight fraction non-volatile	1 g/g	4	Product
Density non-volatile	3 g/cm^3	3	> 95 % salts; see § 2.4.1
Initial particle distribution			
Median (C.V.)	75 (0.6)	1	See above
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	5.0 mg/min	1	See above
Release duration	1 min	2	I.e. ‘spray’ duration
Uptake			
Uptake fraction	1	2	Potential dose

7 Sanitary products

In this chapter, the application of sanitary cleaners is described. The cleaning of the bathroom presents particular problems. Normal organic and inorganic soils as well as calcium and rust deposits from the water need to be removed. Due to the different kinds of soils and of surfaces, various special cleaners can be used. The use of bathroom cleaning products is discussed in section 7.1. The toilet cleaners are dealt with in section 7.2 and toilet rim-cleaners, auto-active, come up in section 7.3.

7.1 Bathroom cleaners

Composition

General formula of bathroom cleaners:

Bathroom cleaner	**Liquid, mild**[5] **%**	**Liquid, strong**[5] **%**	**Spray**[27] **%**
Surfactants			1 - 5
Anionic surfactants	1 – 15	0 – 5	
Non-ionic surfactants	1 – 5	1 – 5	
Cationic surfactants		5 – 15	
Builders			1 - 10
NTA or polycarboxylates	0 – 15		
Acids			+
Citric acid	0 – 15		
Sulfonic -, lactic -, formic acid		5 – 30	
Solvents	0 – 15		
Isopropanol			
Additives			
Thickening agents	< 1	< 1	< 1
Preservatives	< 1	< 1	
Dye	< 1	< 1	< 1
Perfume	< 1	< 1	
Water	50-90	65-95	70 - 95

+: ingredient of bathroom sprays

For ingredients in bathroom cleaners, see section 1.5.

7.1.1 Bathroom cleaning sprays

Use

The scenario describes the spraying with a trigger spray and cleaning of the walls of a shower cubicle. The area is estimated at 0.80 m (length/ width) x 4 x 2.0 m (height) = 6.4 m^2. When cleaning the shower cubicle, sometimes the trigger spray is aimed above the head, before the chest, or more downwards to the wall.

When using a trigger spray for cleaning, the scenarios for modelling inhalation exposure vary

among the different use phases. For spraying, the first phase, to calculate the exposure to aerosol particles the spray model is used for inhalation exposure and the model 'constant rate' for dermal exposure.
During leaving on and cleaning, compounds evaporate from the product, which is sprayed on the surface. To this end the model 'evaporation from a constant surface' is used. During cleaning the surface, dermal exposure could occur which is calculated with the model 'instant application'.

Phase 1 application: spraying
General

- *Frequency*

The AISE[20, 11)] gives a range from 1 to 7 a week and a typical value of 2 $week^{-1}$ for the frequency of surface cleaners. For cleaning the bathroom or other tiled or ceramic walls, Weststat[25)] gives a 75th percentile of 4 $month^{-1}$ and a 50th percentile of 2 $month^{-1}$. The default value is set at 1 $week^{-1}$ or 52 $year^{-1}$.

Inhalation: spray model

- *Spray duration*

The calculated 75th percentile for the spraying is derived from Weerdesteijn et al.'s data[12)] (14.3 sec. per m^2; see subsection 2.4.1). For an area of 6.4 m^2, the extrapolated spraying time is 1.5 minutes. For the duration of surface spraying, the AISE gives a range from 2 to 10 minutes. Using these data, the default value for the spraying time is estimated at 1.5 minutes.

- *Mass generation rate*

The default value for the mass generation rate of trigger sprays is set at 0.78 g product/sec (see subsection 2.4.1). As it is assumed that active spraying occurred for a period of 0.75 min during a time span of 1.5 min, the default value mass generation rate is 0.39 g/sec.

- *Weight fraction non-volatile*

Based on the general composition, it is assumed that the non-volatile part in bathroom cleaning sprays is about 10 %; the default value weight fraction non-volatile is set at 0.1 g/g.

Default values for bathroom cleaning spray: spraying the shower walls

	Default value	Q	References, comments
General			
Frequency	52 $year^{-1}$	3	See above
Inhalation			
Exposure, spray model			
Spray duration	1.5 min	3	See above
Exposure duration	25 min	2	Estimate
Room volume	10 m^3	3	Bathroom[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	2 hr^{-1}	3	Bathroom[2)]
Mass generation rate	0.39 g/sec	3	See above
Airborne fraction	0.2 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.1 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	46 mg/min	3	See § 2.4.2
Release duration	1.5 min	3	I.e. spray duration
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

Phase 2 application: leaving on and cleaning

Inhalation: vapour, evaporation from constant surface

- *Product amount*

The AISE [20)] gives an amount for surface spray from minimal 5 to maximal 30 gram. The average mass generation rate is set at 0.39 g/s (see above) with a spray duration of 90 sec. Therefore, the amount for spraying is 0.39 g/s x 90 s = 35.1 g; the amount on the surface is estimated at 85% of 35.1 g is 30 gram, which is set as default value.

- *Molecular weight matrix*

Assuming that the water fraction is 0.5, the molecular weight matrix is
18 g/mol / 0.5 = 36 g/mol (see subsection 2.2.2).

Dermal uptake, diffusion through skin

- *Application duration*

The calculated 75th percentiles for the cleaning time are derived from Weerdesteijn et al.'s[12] data (110 sec. per m^2; see subsection 2.4.1). For an area of 6.4 m^2, the extrapolated cleaning time is 704 sec or 11.7 min. For surface cleaning liquid, the AISE gives a duration of task ranging from 10 to 20 minutes. Weststat [25] gives a 75th percentile of 45 minutes and a 50th percentile of 30 min. for cleaning bathroom walls.
Using these data, the default value for the exposure time is estimated at 20 minutes.

Default values bathroom cleaning spray: cleaning the shower walls

	Default value	Q	References, comments
General			
Frequency	52 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	25 min	2	Estimate
Product amount	30 g	2	See above
Room volume	10 m^3	3	Bathroom[2]
Ventilation rate	2 hr^{-1}	3	Bathroom[2]
Release area	6.4 m^2	3	See above
Application duration	20 min	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	36 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2]
Product amount	0.3 g	1	1% of 30 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	20 min	2	I.e. application duration

7.1.2 Bathroom cleaning liquids

Use

Bathroom cleaning liquids (containing acids) are periodically applied as descaling products[5] and the frequency is estimated at 4 times a year. The scenario describes the mixing and loading of 44 g bathroom cleaning liquid in a bucket with 2 litres water and the cleaning of the walls of a shower cubicle which has an area of
0.80 m (width) x 2.0 m (height) x 4 = 6.4 m^2. For this cleaning it is assumed that one uses the bathroom cleaner concentrated.

Mixing and loading

- *Molecular weight matrix*

Assuming that the water fraction is 0.7, the molecular weight matrix is 18 g/mol / 0.7 = 26 g/mol (see subsection 2.2.2).

Default values for bathroom cleaning liquid: mixing and loading

	Default value	Q	References, comments
General			
Frequency	4 $year^{-1}$	2	Estimate
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See § 3.2.1
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	2 hr^{-1}	1	Bathroom[2)]; see § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See § 3.2.1
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	26 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	See § 3.2.1

Cleaning

Inhalation: vapour, evaporation from increasing area

- *Product amount*

The amount, which is used for cleaning, is estimated at 40 ml of the diluted product per m^2. For 6.4 m^2, an amount of 260 ml or 260 gram of the *diluted* product is required for cleaning. Only the amount on the walls of the shower cubicle is taken into account for the default.

- *Weight fraction*

Per 2 litres wash water volume, 44 g bathroom cleaner is used, which gives a dilution of 45. The weight of the suds is the weight fraction of the product divided by the dilution factor (W_f / 45).

Default values for bathroom cleaning liquid: cleaning the shower walls

	Default value	Q	References, comments
General			
Frequency	4 $year^{-1}$	2	Estimate
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	25 min	2	Estimate
Product amount $_{dilution}$	260 g	2	See above
Weight fraction $_{dilution}$	W_f / 45	3	Dilution 45x; see above
Room volume	10 m^3	3	Bathroom[2)]
Ventilation rate	2 hr^{-1}	3	Bathroom[2)]
Release area	6.4 m^2	3	See above
Application duration	20 min	2	See § 7.1.1
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			See § 3.1.2
Exposed area	1900 cm^2	3	Area hands[2)] and forearms
Weight fraction $_{dilution}$	W_f / 45	3	Dilution 45x; see above
Product amount $_{dilution}$	19 g	1	Skin layer 0.01 cm[11)]; see § 2.3
Uptake, diffusion through skin			
Concentration $_{dilution}$	W_f /45 g/cm^3	3	Density water 1 g/cm^3
Exposure time	20 min	2	I.e. application duration

7.2 Toilet cleaners

Toilet cleaners are divided in two different products i.e. toilet cleaners containing acids for removing calcium or metal salts and toilet cleaners containing a bleaching system which can be hydrogen peroxide or hypochlorite (see section 1.5). In this chapter both types of toilet cleaners used *in* the lavatory pan are described.
The toilet seat can be cleaned with wet tissues. These contain non-ionic surfactants, alcohol, perfume, and preservatives (see also section 5.1). Hygienic wet tissues might contain as well active hydrogen peroxide. The application of wet tissues for surfaces is described in section 5.2 and it is not discussed in this chapter.

Composition

General formula of toilet cleaners[5,17,31]:

Toilet cleaners	**Liquid, acid**[5,17] **%**	**Liquid, bleaching**[5,31] **%**
Surfactants		
Anionic surfactants	0 – 10	2 – 10
Non-ionic surfactants	1 – 15	2 – 10
Cationic surfactants	0 – 15	
Acids Sulfonic, citric, lactic, formic phosphoric and sulfamic acid	0 – 10	
Salts & acids/ bases		2 – 10
*Bleaching agents** 1. active hydrogen peroxide 2. active hypochlorite		1 – 5
Additives		
Polymers	0 – 5	0 – 5
Builders		0 – 2
Dye	< 1	< 1
Perfume	< 1	< 1
Water	85 – 90	85 – 90

* Bleaching products with active oxygen could be acid or alkaline. Products containing hypochlorite are always alkaline.

For ingredients in toilet cleaners, see section 1.5.

Use

The scenario describes the cleaning of the interior of the toilet pan. The toilet cleaner is spout with a squeeze bottle under the rim of the toilet pan. After leaving the toilet cleaner to soak in the toilet pan, the toilet pan is brushed. Dermal contact with toilet cleaner will happened while brushing the lavatory pan. It is assumed that afterwards the hands are washed and that in the duration time of brushing the toilet pot, dermal exposure occurs to the diluted product.

Toilet cleaner, acid

General

- *Frequency*

Weegels[10] investigated the use of toilet cleaners. The results were as follows: mean frequency 0.3 day^{-1} (S.D. 0.6; n=10) which equals 2.1 $week^{-1}$. The calculated 75th percentile is 0.708 day^{-1} or 5.0 $week^{-1}$. According to the AISE[20, 11], the maximum use frequency is 2 times a week. The 75th percentile value of Weegels is set at default value i.e. 5.0 $week^{-1}$ or 260 $year^{-1}$.

Inhalation: vapour, evaporation from constant surface

- *Application duration*

For the duration of cleaning the toilet, Weegels found a mean value of 72 seconds

(S.D. 41; n=12) with a 75th percentile of 100 sec. The duration ranged from 10 to 150 seconds. For application duration, the default value is set at 2 min.

- *Product amount*

For cleaning the toilet, the subjects used the products undiluted. Weegels[10)] found an average amount of 40 gram toilet cleaner (S.D. 22; n=12)[10)] with a 75th percentile of 55 gram. The AISE[20, 11)] gives 30 gram as typical amount for liquid toilet cleaners; for gel toilet cleaners, the typical amount is 25 g with a range from 20 to 35 gram.
The value of 55 gram, found by Weegels, is used; the total amount of toilet cleaner and water in the toilet pan is estimated at 1 litre. The default value for (diluted) product amount is set at 1000 gram.

- *Weight fraction*

An amount of 55 gram of toilet cleaner is diluted in 1 litre water which gives a concentration of 55 g/l and a fraction of 0.055 g product /g water. This means a dilution of about 18 times; the weight fraction of the solution is the weight fraction of the product divided by the dilution factor (W_f/ 18).

- *Release area*

For the release area, it is assumed that evaporation takes place from the toilet pan. The area is estimated at 750 cm^2.

Dermal uptake: diffusion through skin

- *Exposure time*

If dermal exposure occurs, the duration for brushing the lavatory pan can be used. The AISE[20, 11)] gives less than a minute for duration of task. Weegels[10)] gives as mean duration of brushing the lavatory pan 24 seconds (S.D. 11), which results in a 75th percentile of 31.5 sec. or 0.5 min. The default value for exposure time is set at 3 minutes.

Toilet cleaner, bleach agent

- *Frequency*

Weegels[10)] also investigated the cleaning with a bleaching agent: the average was 7 times a month (S.D. 4; n=10) with a 75th percentile of 10 $month^{-1}$ or 120 $year^{-1}$. This value is set as default value for frequency.

- *Product amount*

For cleaning the toilet with bleach the average amount was 55 g (S.D. 37; n=9)[10)] which gives a 75th percentile of 80 gram. The total amount of toilet cleaner and water in the toilet pan is estimated at 1 litre. The default value for (diluted) product amount is set at 1000 gram.

- *Weight fraction*

An amount of 80 gram of bleach is diluted in 1 litre water which gives a concentration of 80 g/l and a fraction of 0.080 g product /g water. This means a dilution of about 12 times; the weight fraction of the solution is the weight fraction of the product divided by the dilution factor (W_f/ 12).

For the other default values: see above, toilet cleaner acid.

Default values for toilet cleaner, acid and bleach

	Default value	Q	References, comments
General			
Frequency			
Acid cleaner	260 $year^{-1}$	3	See above
Bleach	120 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	3 min	3	Estimate
Product amount $_{dilution}$	1000 g	2	Acid cleaner & bleach; see above
Weight fraction $_{dilution}$			
Acid cleaner	W_f / 18	2	Dilution 18x; see above
Bleach	W_f / 12	2	Dilution 12x; see above
Room volume	2.5 m^3	3	Toilet[2)]
Ventilation rate	2 hr^{-1}	3	Toilet[2)]
Release area	0.075 m^2	3	See above
Application duration	2 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/ mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount $_{dilution}$	2.2 g	1	Acid cleaner & bleach
			Skin layer 0.01 cm[11)]; see § 2.3
Weight fraction $_{dilution}$			
Acid cleaner	W_f / 18	2	Dilution 18x; see above
Bleach	W_f / 12	2	Dilution 12x; see above
Uptake, diffusion through skin			
Concentration $_{dilution}$			
Acid cleaner	W_f / 18	2	Density 1 g/cm^3
Bleach	W_f / 12	2	Density 1 g/cm^3
Exposure time	3 min	3	See above

7.3 Toilet rim cleaners

Boxes containing toilet rim cleaners (auto-active) cling to the inner ring of the toilet bowl. On each flush of the toilet, they release active ingredients into the bowl. The toilet rim cleaners or flush/ rinse cleaners should maintain a clean bowl, that smells fresh. There are solid and liquid toilet rim cleaners.

Composition

General formula of toilet rim cleaners[a)]:

Toilet rim cleaners	**Liquid %**	**Solid %**
Surfactants		
Anionic surfactants	10 – 30	30 – 50
Non-ionic surfactants	2 - 10	1 - 10
Filler		40 – 60
Sodium sulphate		
Additives		
Perfume	5-10	3 - 10
Water	rest	

a): information from the Dutch Association for Soap Manufacturers (NVZ), January 2004
For ingredients in toilet rim cleaners, see section 1.5.

Inhalation: vapour, constant rate
This scenario is used for calculating the steady air concentration. If the below mentioned default values are used, ConsExpo 4.0 calculates the mean event concentration in the air during the day and the inhalation exposure during 1440 minutes i.e. 24 hours. However, it is assumed that the user goes to the toilet 10 times a day for 5 minutes.
The external inhalation exposure during 50 minutes a day can be calculated as follows:
mean event concentration (mg/m^3) x inhalation rate (0.00896 m^3/ min) x exposure duration (50 min./day) / body weight (65 kg) = mean event conc. x 0.00689 (mg/kg/day)
The internal inhalation exposure is the external inhalation exposure multiplied with the uptake fraction which is worst-case set at 1; thus, the internal inhalation exposure is
mean event conc. x 0.00689 (mg/kg/day)

- *Product amount, liquid*

For a liquid toilet rim cleaner, containing 55 ml fluid (product information) with an estimated density of 1.3 g/cm^3, the amount is about 70 g.

- *Emission duration*

Assuming that a toilet block of 30 gram can last for 30 days (product information), the default value for emission duration is set at 43200 minutes.
As it is assumed that a liquid product can last for 60 days, the emission duration is set at 86400 minutes.

Default values for toilet rim cleaner

	Default value	Q	References, comments
General			
Frequency	365 $year^{-1}$	3	Every day
Inhalation			
Exposure, constant rate			
Exposure duration	1440 min	1	I.e. 24 hours
Product amount			
Solid	30 g	2	Product information
Liquid	70 g	2	See above
Room volume	2.5 m^3	3	Toilet[2)]
Ventilation rate	2 hr^{-1}	3	Toilet[2)]
Emission duration			
Solid	43200 min	2	See above
Liquid	86400 min	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	9 L/min	3	Rest[22)]

Note: calculation for equilibrium air concentration

8 Floor, carpet and furniture products

In this chapter, the use of floor, carpet and furniture cleaners is described.
Floor care products are discussed in section 8.1, in which the application of floor cleaners (subsection 8.1.1), floor polishes (subsection 8.1.2) and of floor mopping systems (subsection 8.1.3) are given. In subsection 8.1.4, the other floor products such as floor strip products and floor seal products are described.
Then, in section 8.2 carpet cleaners are discussed. The manual application of carpet cleaner liquids is given in subsection 8.2.1, the machine use in subsection 8.2.2. Carpet powders and carpet spot removers are discussed in subsection 8.2.3 and 8.2.4, respectively.
Finally, care products for wooden and leather furniture are described in subsection 8.3.1 and 8.3.2, respectively.

8.1 Floor products

Floor care products combine cleaning and polishing aspects. Depending on their application function, these products contain either more cleaning compounds or more protecting compounds. There are floor-cleaners, floor-polishes, combined products, floor seal products and floor strip products. In this section, default values for floor-cleaners and floor-polishes are given. Of other floor products, like floor strip products and floor seal products, only general information is given.

Composition

General formula of floor cleaning and protecting products

Floor products	**Cleaner liquid**[5)] **%**	**Combined product**[5)] **%**	**Polish**[5,a)] **%**	**Sealer**[5)] **%**	**Stripper A**[5,27)] **%**	**Stripper B**[27)] **%**
Surfactants			0-5			
Anionic surfactants	5-15	< 5			0-15	
- soap	1-30	1-15			0-5	
Non-ionic surfactants	5-15	< 5			0-5	
Builders NTA, phosphates, sodium silicate	< 5	0-5			3-7	
Bases Ammonia / caustic soda					3-10	
Solvents	0-15					
Alcohols		5-25				
2-butoxyethanol						10-50
Alkylphenoxy-polyethoxy ethanol (nonoxynol)						2-5
Glycols / glycolethers		1-5	0-5	0-5	0-15	0-20
Monoethanolamine					3-15	10-30
Hydrotropes Cumeensulphonate					0-5	
Waxes Carnaubawax Polyethyleen wax		1-10	1-5	0-5		
Resins and polyacrylates		1-10	10-25	10-80		
Plasticizers Tributoxy ethylphosphaat Phtalaten, glycolethers		0-5	1-10	0-5		
Additives						
Preservatives	< 1	< 1	< 1	< 1	< 1	
Perfume	< 1		< 1	< 1	< 1	
Water	> 50	50-70	80	70-85	60-80	

a): information from the Dutch Association for Soap Manufacturers (NVZ), January 2004

For a general formula of floor wet tissues, see chapter 5 all-purpose wet tissues with alkalis as builders.
For ingredients in floor products, see section 1.5.

8.1.1 Floor cleaning liquids

Floor cleaners, which contain soap, are meant for daily or periodically removing all kinds of grease and dirt from different sorts of floors. By mopping the floor with a soap solution, a thin layer of the cleaner, which is not wear-resistant, is applied onto the floor that makes afterwards cleaning easier. Therefore, the wiped surface should not be rinsed with clean water[5)].
Combined floor products are designed for cleaning and for preserving the condition of the existing wax or polymer coating. These products, containing resins and polyacrylates, provide a protective layer. However, it is difficult to combine these two functions: either the product cleans reasonably and the protective layer is of minor quality, or it applies a moderately protective layer and it scarcely cleans.

Use

The scenario describes the cleaning of the floor in the living room, which has an area[2)] of 22 m^2. For this purpose 250 gram floor cleaner is diluted in a bucket with 5 litres water, the cleaning is done twice a week. Exposure can occur during mixing and loading, and during cleaning; only exposure during the application of floor products is described.
For mopping the floor, a floor cloth is used. From time to time it is rinsed in the suds and wringed out by hand. After the cleaning, the user stays in the room for 4 hours.

Mixing and loading

The default values for mixing and loading equals that of all-purpose cleaners (see section 5.2).

Cleaning

Inhalation: vapour, evaporation from increasing area

- *Application duration*

Weerdesteijn et al.[12)] gives a cleaning time of 15 min for cleaning the kitchen floor with an surface area of 4.1 m^2. The AISE[20, 11)] gives a duration range from 10 to 20 minutes for cleaning surfaces. For cleaning the floor of the living room, the use duration is estimated at 30 min.

- *Product amount*

When cleaning a surface, the amount of solution which is left on the cleaned surface is estimated at 40 ml of the diluted product per m^2 (see section 5.2). For 22 m^2, an amount of 880 ml or 880 gram is left on the surface.

- *Weight fraction*

The concentration used in a solution of combined floor products ranges from 0.5 % to 2.5 % [5)]. Floor cleaners are applied in a dilution of 0.5 % to 5.0 % [5)]. The latter is taken as concentration for the diluted product; for making a 5 litres cleaning solution, an amount of 250 gram is needed; this value is also given in the production information of linoleum cleaners. The dilution is then 20 times. Thus, the weight fraction of the suds is the weight fraction of the product divided by the dilution factor (W_f / 20).

Default values for floor cleaning liquid: cleaning

	Default value	Q	References, comments
General			
Frequency	104 $year^{-1}$	3	Estimate
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	240 min	3	Default
Product amount $_{dilution}$	880 g	2	See above
Weight fraction $_{dilution}$	W_f / 20	3	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Release area	22 m^2	4	Living room[2)]
Application duration	30 min	2	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			See § 3.1.2
Exposed area	1900 cm^2	3	Area hands[2)] and forearms
Weight fraction $_{dilution}$	W_f / 20	3	See above
Product amount $_{dilution}$	19 g	1	Skin layer 0.01 cm[11)]; see § 2.3
Uptake, diffusion through skin			
Concentration $_{dilution}$	W_f /20 g/cm^3	3	Density water 1 g/cm^3
Exposure time	30 min	2	I.e. application duration

8.1.2 Floor mopping systems

Use

Floor wet tissues

These solid, moist cleaning tissues are ready for use when taken from the package and they are suitable for single use. After wiping the floor surface, it is not necessary to rinse the surface and the tissues are thrown away. These tissues with a weight of circa 10 g contain about 25 gram solution.

Mopping systems

On the market are all-in-one, ready-to-use mopping system. A cleaning pad must be applied to the mop head; the area is sprayed with the cleaning solution and then mopped. The solution dries in moments. In this chapter, this mopping system is considered because the amount used is larger than for cleaning the floor with a wet tissue.

The scenario describes the cleaning of the floor with such an all-in-one mop which is done in the living room with a floor area[2)] of 22 m^2. No data were found for spraying and cleaning the

floor; therefore, data from Weerdesteijn et al.[12)] is used. For an area of 60 x 60 cm, the amount sprayed was 3.35 g (S.D. 0.98) with a calculated 75th percentile of 4.016 g. Thus, to clean an area of 22 m^2 an amount of 245 g is needed.
Dermal exposure occurs when the pad is taken of the mop head and afterwards. The exposure duration for dermal exposure is set at 3 min. It is assumed that 10 % of the used amount remains in the pad i.e. 24.5 g and that 1% of this amount contacts the skin (see section 2.3) resulting in a product amount of 0.25 gram.
See also all-purpose tissues (section 5.4) and floor cleaners (subsection 8.1.1).

Default values for floor mopping systems

	Default value	**Q**	**References, comments**
General			
Frequency	104 year^{-1}	3	See § 8.1.1
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	240 min	3	Default
Product amount	245 g	2	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Release area	22 m^2	4	Living room[2)]
Application duration	30 min	2	See § 8.1.1
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/mol	2	See § 5.4
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: ¼ area hands[2)]
Product amount	0.25 g	1	See above
Uptake, diffusion through skin			
Exposure time	3 min	2	See above

8.1.3 Floor polishes

Floor-polishes are meant for keeping the floor in a good state of repair; therefore, a protective and relative durable wax coating is applied on the floor. The cleaning can be done easier and less cleaning is necessary. The coating is applied in an undiluted form by waxing the floor. After drying, a gleaming film is formed.
Floor-polishes contain ingredients such as waxes and polymers. When a product contains more waxes, the applied wax coating must be polished up and it is not resistant to alkaline cleaning products. Wax has a 'natural' appearance. However, if the floor polish contains more polymers a polymeric film will be formed. This is often dry self-glossing after wet wiping, making polishing of the deposited films needless. Furthermore, it is relatively wear-

resistant and it is difficult to remove. Modifying the properties of these products means altering the ratio between wax and polymer. The text above is derived from Vollebregt[5].

Use
The scenario describes the polishing of the floor in the living room, which has a surface area of 22 m^2 [(2)]. The polishing of the cleaned floor is done twice a year with the undiluted product. The product is sprinkled on a cloth and is manually rubbed on the floor, which is polished up. Dermal exposure occurs by hand contact with the cloth.

General

- *Frequency*

Using the data of Versar[26], a 75th percentile for the frequency is estimated at 2 times in 6 months. Weststat[25] gives a 75th percentile of 6 times a year for wood floor cleaners. For household use, a touch-up twice a year is sufficient (product information). It is here assumed that 2 times a year the floor of the living room is polished.

Inhalation: vapour, evaporation from increasing area

- *Application duration*

For use duration, Weststat gave a 75th percentile of 90 minutes which is set as default value.

- *Exposure duration*

After polishing the floor, it is assumed that the user will leave the room (product information).

- *Product amount*

For wax or for floor polish parquet / linoleum, the product information gives that 1 litre product is sufficient for 40 m^2. For polishing the floor area of the living room, the product amount is estimated at 550 gram for 22 m^2.

- *Molecular weight matrix*

Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol (see subsection 2.2.2).

Default values for floor polish (water based)

	Default value	Q	References, comments
General			
Frequency	2 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	90 min	3	See above
Product amount	550 g	3	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Release area	22 m^2	4	Living room[2)]
Application duration	90 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	430 cm^2	3	One hand: 0.5 area hands[2)]
Product amount	5.5 g	1	1% of 550 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	90 min	3	See above

8.1.4 Floor strip and floor seal products

Floor strip products
Old protective layers can be removed by floor-strippers, which are often strong alkaline. The alkaline concentration depends on the age of the layer and on the difficulty of removing the layer[5)].

Exposure
Although floor strip products are different products compared to floor polishers, the default values for the exposure is derived from floor polishers (see subsection 8.1.3). The frequency is estimated at once a year (Q = 2).

Floor seal products
Floor seal products seal the pores of the floor such as linoleum; afterwards, the floor is covered with a basic coating. Dirt, water and grease have more difficulties to get into the pores of the floor. Contiguous, a polymeric or wax layer can be applied by using a floor-polish.

Exposure
Before using new linoleum, it is recommended to seal it. The frequency is estimated at once per ten years i.e. 0.1 $year^{-1}$ (Q = 1).
By sealing floors with a tough acrylic layer, the gleam of waxes will be enhanced and the detergent resistance will be improved. Because these products impregnate the floor, the applied amount depends on the product and on the porosity of the linoleum. The product amount varies between 1 to 2 litres for 22 m^2 (product information). The default value for amount is set at 1500 gram (Q = 2).
Although floor seal products are different products compared to floor polishers, the other default values for the exposure is derived from floor polishers (see subsection 8.1.3).

8.2 Carpet products

Carpet cleaners are used for cleaning all kinds of carpets, rugs and upholstery. They can dissolve and suspend fixated dirt and remove it from the fibre. The cleaning compounds must adsorb the loosened soil and after drying they must be easily vacuumed off. In this section the following products are distinguished: liquids (manual, subsection 8.2.1 and machine use, subsection 8.2.2), powders (subsection 8.2.3) and sprays (subsection 8.2.4).
Carpet fresheners are for reducing malodours that may be found in carpets and rugs. In this section carpet fresheners are not discussed.

Composition

General formula of carpet cleaners:

Carpet cleaner	**Liquid**[5)]	**Powder**[4,5)]	**Spot remover liquid**[5)]	**Spot remover foam spray can**[4,27)]
	%	**%**	**%**	**%**
Surfactants			0 - >30	1 – 5
Anionic surfactants	0 – 15	1 – 5		
Non-ionic surfactants	0 – 15			
Builders	0 – 5			
Polycarboxylates				
Solvents & hydrotropes				
Ethanol, isopropylalcohol	0 - >30	7 – 14	30 – 40	0 – 3
Glycolethers			0 – 15	0 – 7
Additives				
Polymers				0 – 5
Foam stabilizers				0 – 2
Preservatives	< 1			
Perfume	< 1	< 1		
Carriers e.g. cellulose		15 - 60		
Water	60 – 90	40 – 80		Rest
Propellants				< 10

For ingredients in carpet cleaners, see section 1.5.

8.2.1 Carpet cleaning liquids

Use

The scenario describes the manual cleaning of fitted carpet in the living room. An area of 22 m^2 is cleaned once per 2 years with a solution of carpet liquid. The cleaning is done with a hand brush. 500 ml carpet cleaner is diluted in a bucket to 10 litres water. During the cleaning there might be dermal and inhalation exposure to the solution.

Mixing and loading

For the exposure during mixing and loading, the default values are described in section 5.2, mixing and loading all-purpose cleaners.

General

- *Frequency*

Using the data of Versar[26)], a 75th percentile for frequency can be estimated at 1.5 times per 6 months. The recommended frequency for cleaning is once per 2-3 years, once per 1-2 years and once per 3 years (product information). The default value is set at once per 2 years or 0.5 per year.

Inhalation: vapour, evaporation from constant surface

- *Exposure duration*

For mixing and loading 60 g all-purpose cleaner in 5 litres water, an exposure duration of 0.75 minutes is given in section 5.2. For the mixing and loading of 500 ml carpet cleaner in 10 litres water, the exposure duration is also set 0.75 minutes.

- *Application duration*

For mixing and loading 60 g all-purpose cleaner in 5 litres water, application duration of 0.3 minutes is given in section 5.2 which is set as default value.

Default values for carpet cleaning liquid: mixing and loading

	Default value	**Q**	**References, comments**
General			
Frequency	0.5 $year^{-1}$	3	See above
Inhalation			
Exposure, evaporation from constant surface			
Exposure duration	0.75 min	3	See above
Product amount	500 g	3	See § 2.2.2
Room volume	1 m^3	1	See § 2.2.2
Ventilation rate	0.5 hr^{-1}	1	Living room[2)]; see § 2.2.2
Release area	0.002 m^2	2	See § 2.2.2
Application duration	0.3 min	3	See above
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	36 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.010 g	3	See § 2.2.3
Uptake, diffusion through skin			
Exposure time	0.75 min	3	I.e. exposure duration

Cleaning

Inhalation: vapour, evaporation from increasing area

- *Application duration and exposure duration*

When the whole area of the carpet is cleaned, the user leaves the room. So, the exposure duration is the same as the application duration. For a thorough cleaning of carpet the use duration and exposure duration are estimated at 5 minutes per m^2. Thus, for 22 m^2 carpet the cleaning duration is 110 minutes.

- *Product amount*

The amount for carpet and upholstery cleaner is given as 500 ml for 15-20 m^2 (product information). This quantity should be diluted to 10 litres; therefore, the maximal amount of the diluted cleaner is 10 000 ml / 22 m^2 = 450 ml /m^2. Foam cleaning and spray extraction leave up to 0.5 l cleaning solution / m^2 carpet behind, requiring a drying time of up to 4 days[4)]. For (diluted) product amount the default value is set at 2200 ml.

- *Weight fraction*

The weight fraction must be divided by the dilution factor, which is 20 times (500 ml in 10 litres).

Dermal exposure: instant application

- *Product amount*

During the brushing of the product, dermal exposure can occur. Exposure data are not available. For estimating dermal exposure, the default values for the amount of paint which contacts the skin during painting are taken. For low viscous paint such as stain, it is assumed that 0.27% of the applied stain ends up on the skin.
For cleaning 22 m^2 carpet 10 litres solution is needed; 0.27 % equals 27 ml diluted carpet cleaner. The default value for product amount is set at 27 g.

Default values for carpet cleaner liquid: manual cleaning of fitted carpet

	Default value	Q	References, comments
General			
Frequency	0.5 $year^{-1}$	3	See mixing and loading
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	110 min	3	See above
Product amount $_{dilution}$	10 000 g	2	See above
Weight fraction $_{dilution}$	W_f / 20	3	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 hr^{-1}	3	Living room[2)]
Release area	22 m^2	4	Living room[2)]
Application duration	110 min	3	See above
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	18 g/mol	4	Matrix is water; see § 2.2.2
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	860 cm^2	3	Area hands[2)]
Weight fraction $_{dilution}$	W_f / 20	3	See above
Product amount $_{dilution}$	27 g	2	See above
Uptake, diffusion through skin			
Concentration	W_f / 20	3	Density 1 g/cm^3
Exposure time	110 min	3	See above

8.2.2 Spray extraction machine

Exposure can be caused during mixing and loading and during the cleaning up of the machine. Default values for mixing and loading are given in subsection 8.2.1 carpet cleaner liquids. During application of carpet cleaner liquids in a spray extraction machine, the dermal exposure is assumed negligible; default values for inhalation exposure during application are given in subsection 8.2.1: carpet cleaner liquids, manual cleaning of fitted carpet.

8.2.3 Carpet powders

Carpet cleaning can also be done by the use of (wet) powders, which contain water, solvents and surfactants to emulsify the soil. The soil is absorbed onto the powders; after drying, the residues together with the bound dirt can be removed by vacuuming.

Use

The scenario describes the treating of fitted carpet in the living room. An area of 22 m^2 is cleaned with carpet powder once per 2 years. After scattering a thin layer of powder on the carpet, the brushing is done with a dry hand brush. The scattering and the brushing are done

per square metre. If the powder is completely dry, that is after about 20 minutes, it must be thoroughly vacuumed up with a vacuum cleaner.

Application

Inhalation: spray model

- *Mass generation rate*

For cleaning the carpet, an amount of 50-100 g per m^2 is given (product information). It is assumed that 2200 gram is necessary for dusting the fitted carpet of the living room[2)]. If 100 g is scattered in one minute, 2200 g of powder is scattered in 22 min. and the mass generation rate is 100 g/min = 1.7 g/sec.

Dermal exposure: constant rate

- *Contact rate*

Using the data mentioned in section 6.2, the default value for contact rate is set at 10.7 mg/min. To what extent this value is applicable to the 'contact rate' of carpet powder is unknown, therefore the quality factor is set at 1.

- *Initial particle distribution*

In the TNsG's[41)] a 'Consumer product spraying and dusting' model is stated 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) [41)].
Based on this data, the default value for the initial partial distribution is a lognormal distribution with a median of 75 µm and a coefficient of variation of 0.6. To what extent this value is applicable to the 'initial particle distribution' is unknown; considering the use of carpet powder the particles are presumably larger than 75 µm and the given default values for the initial particle distribution reflect a worst-case assumption. The quality factor is set at 1.

Dermal exposure: constant rate

- *Contact rate*

In the above-mentioned dusting model (TNsG[41)]), the subjects in the study applied crack and crevice powders in a kitchen. The dermal exposure on hands and forearms ranges from 0.4 to 4.18 mg/min with a 75^{th} percentile of 2.83 mg/min. The dermal exposure for legs, feet and face ranges from 0.22 to 6.56 mg/min with a 75^{th} percentile of 2.15 mg/min. Using these data, the default value for contact rate is set at 5.0 mg/minute. To what extent this value is applicable to the 'contact rate' of carpet powder is unknown, therefore the quality factor is set at 1.

Default values for carpet powder: scattering

	Default value	Q	References, comments
General			
Frequency	0.5 $year^{-1}$	3	See § 8.2.1
Inhalation			
Exposure, spray model			
Spray duration	22 min	2	See above
Exposure duration	22 min	2	See above
Room volume	58 m^3	4	Living room[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Mass generation rate	1.7 g/ sec	2	See above
Airborne fraction	0.2	1	No available data; see § 2.4.1
Weight fraction non-volatile	1 g/g	4	Product
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	75 (0.6)	1	See above
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	5.0 mg/min	1	See above
Release duration	22 min	2	I.e. 'spray' duration
Uptake			
Uptake fraction	1	2	Potential dose

Post-application: exposure to residues

After cleaning with carpet powder the carpet will be vacuumed. There are no data available about the amount of residues that stays on the carpet. It is assumed that 10% of the used amount settles on the carpet. The exposure during post-application is calculated for crawling children, if they are exposed to these surfaces and its residues. Dermal exposure of children can take place on any uncovered skin, that is, on the head, the arms and hands, and on the legs and feet. If dermal exposure of children occurs, they can also be exposed orally via hand–mouth contact. The hands form about 20 % of the total uncovered skin (see dermal exposure). It is assumed that 50 % of the product that ends up on the hands is taken in orally. This means that via hand-mouth contact 10 % of the calculated external dermal exposure is ingested and that the internal dermal exposure is 90 % of the calculated external dermal exposure.

It is assumed that a child (default 10.5 months; 8.69 kg)[2)] crawls over the treated surface for 1 hour a day during a 14-day period. Exposure after application is described using the dermal exposure model 'rubbing off' and the oral exposure model 'direct intake'.

Dermal exposure: rubbing off

In the model 'rubbing off' the product is initially applied to a surface and consequently transferred to the skin by dermal contact with the skin.

- *Exposed area*

Infant surface area exposed is calculated based on a child wearing a short-sleeved shirt and a napkin, and no socks or shoes. The exposed area considered is, therefore, hands, feet, forearms and lower legs. The body part percentages of total surface area of exposed body surface area are for hands[45)] and feet[45)] 5.3 % and 7.1 %, respectively, for forearms[46)] and lower legs[46)] the percentages are 6.2% and 8.2%, respectively. The total exposed body part percentage is 26.8 %, the total surface area body[2)] is 4370 cm^2, and as a result, the exposed area is 1170 cm^2.

- *Transfer coefficient*

The 'transfer coefficient' is the surface that is wiped per unit time due to skin contact. For infants aged 6 months to 1-1.5 years, an assumed mean dermal transfer coefficient of 0.6 m^2/ hr is given[47)]. This transfer coefficient is also used in the Fact Sheet Pest Control Products[13)].

- *Dislodgeable amount*

The TNsG[41)] gives a transfer efficiency for dried fluid varying from 3 % (painted wood, MDF) to 60 % (brown rough glazed tile). The US EPA (SOP 8.2.2)[47)] assumes that an average of 50 % of the application rate is available as dislodgeable residue. Based on this data, the default value for dislodgeable *fraction* is set at 30%.
It is assumed that after vacuuming 10 % of the used amount settles on the carpet from which a certain fraction is dislodgeable. If 2200 g of carpet powder is scattered onto 22 m^2, the dislodgeable product amount will be
100 g/ m^2 x 0.1 (residual fraction) x 0.3 (dislodgeable fraction) = 3 g product/m^2. Thus, the dislodgeable amount of carpet powder is 3 g/ m^2.

- *Contact time*

It is assumed that a child (default 10.5 months) crawls over the cleaned surface for 1 hour a day during a 14-day period[13)].

- *Rubbed surface*

The surface that is wiped off is set at 22 m^2, which is the treated surface area of the living room.

Oral exposure: direct intake

- *Amount ingested*

The amount ingested is 10 % of the external dermal exposure calculated with ConsExpo (see above).

Default values for carpet powder: post- application

	Default value	Q	References, comments
General			
Frequency	14 year^{-1}	3	See above
Body weight	8.69 kg	4	Child 10.5 months[2)]
Dermal			
Exposure, rubbing off			
Transfer coefficient	0.6 m^2/hr	2	See above
Dislodgeable amount	3 g/m^2	2	See above
Contact time	60 min	2	See above
Rubbed surface	22 m^2	4	Living room[2)]
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose; calculation internal dose: see above
Oral			
Exposure, direct intake			
Amount ingested	--		Calculated, see above
Uptake			
Uptake fraction	1	2	Potential dose

8.2.4 Carpet spray spot removers

Use

Carpet spot removers are formulated for removing stains and dirt from carpets and upholstery. The scenario describes the spot removal from the carpet in the living room, which is done 10 times a year, with a foam spray can. The carpet spot remover is sprayed on an area of 0.1 m^2. During 3 minutes the foam must absorb into the stain. With paper towels the dirt is absorbed and after that the surface is patted dry.

General

- *Frequency*

In household solvent products: a national survey, Weststat[25)] investigated spot removers. The 75th percentile of frequency is 10 times a year (n = 1390).

Dermal exposure: instant application

- *Product amount*

With a foam spray can of about 625 gram a carpeted area of 15.6 m^2 can be cleaned (product information) i.e. 40 g per m^2. A spotted area of 0.1 m^2 can be cleaned with 4.0 g product. Another product mentions that an amount of 300 ml can clean a surface area of 3.5 m^2 and so, for the spotted area of 0.1 m^2 an amount is needed of 8.6 ml or 7.7 g (estimate density: 0.9 g/cm^3). Using these data, the default value for amount is set at 7 g.
Worst-case is estimated that 1 % of the product amount contacts the skin; i.e. 0.07 g. This occurs during cleaning and rubbing the carpet with paper towels.

Dermal uptake: diffusion through skin

- *Exposure time*

For the use duration, Weststat gives a 75th percentile of 10 minutes which is taken as default value.

Default values for carpet spot removers

	Default value	Q	References, comments
General			
Frequency	10 year^{-1}	3	See above
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.07 g	1	1% of 7 g product; see above
Uptake, diffusion through skin			
Exposure time	10 min	3	See above

8.3 Furniture and leather products

Furniture and leather products include various product forms such as liquids, pastes and aerosols. They are intended to remove dust and stains from wooden furniture surfaces, to produce shine and to provide protection against (water) spots. For this reason, silicone fluids, wax, lemon oil or tung oil are added as ingredient. Lemon oil and tung oil are used in products without water.
Furniture and leather products are applied as cleaning or as caring products; further, both aims can be combined in one product. For the scenario, no difference is made between the various products. Furniture polish and leather furniture spray are described in subsection 8.3.1 and 8.3.2, respectively.

8.3.1 Furniture polish

Use

A cupboard, which is sited in the living room, is treated with a liquid furniture polish once a year. The cupboard measures 1.2 m (width) x 1.9 m (height) x 0.6 m (depth) and it has 4 shelves. Thus, an area of 22 m^2 is treated with undiluted furniture polish. The product is sprinkled on a cloth and is manually rubbed on the wood, which is polished up. In this application there could be dermal exposure.

Composition

A formula for furniture and leather products, cleaning and caring

Cleaning & caring products	**Furniture products, liquid**[34] **%**	**Furniture products, aerosol spray can**[27] **%**	**Leather products, liquid**[27] **%**
Surfactants			< 5
Waxes	51		
Oil			
Turpentine oil	22		
Mineral oil		< 10	10 – 15
Solvents			
Naphtha	20	< 20	
Petroleum distillate			5 – 10
Additives			
Stearic acid	7		
Glycerine			1 – 5
Polymers			< 5
Water		55 – 65	65 – 75
Propellants		< 18	

For ingredients in furniture and leather products, see section 1.5.

Inhalation: vapour, evaporation from increasing area

- *Application duration*

Weststat[25] gives a 75th percentile of 90 minutes for the use duration of wood floor cleaners. For a floor or for a cupboard, the application of waxes is similar. Because the area of this cupboard equals the area of the living room, the default value is set at 90 minutes.

- *Exposure duration*

Weststat[25] gives a 75th percentile of 2 hours for the time spent in the room after last use of wood floor cleaners including those who did not spend any time in the room. The default value for exposure duration is set at 240 minutes (default).

- *Product amount*

For wax or for floor polish parquet, the product information gives that 1 litre product is sufficient for 40 m^2 (see subsection 8.13, floor polish). Treating parquet or a cupboard is comparable; therefore, for polishing the cupboard surface, the product amount is estimated at 550 gram for 22 m^2.

- *Molecular weight matrix*

For products containing oil or wax, the density is about 0.8 g/ cm^3. Assuming that turpentine is a solvent in these products, fraction 0.5 and M_w 136, the molecular weight matrix is calculated as follows: 136 / 0.5 = 272 g/mol (see subsection 2.2.2).

Default values for furniture polish: manually rubbing a cupboard

	Default value	Q	References, comments
General			
Frequency	1 year^{-1}	2	See use
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	240 min	3	Default; see above
Product amount	550 g	3	See above
Room volume	58 m^3	4	Living room[2)]
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Release area	22 m^2	4	See above
Application duration	90 min	3	See above
Temperature	20 ˚C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	272 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	430 cm^2	3	One hand: 0.5 area hands[2)]
Product amount	5.5 g	1	1% of 550 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	90 min	3	I.e. application duration

8.3.2 Leather furniture spray

Use

For a spray application a leather sofa is treated once a year; the surface area is estimated at 5.5 m^2. The product amount is estimated at one fourth of that of a furniture product i.e. about 135 gram. The mass generation rate is 1.5 g/s (see subsection 2.4.1); assuming that active spraying actually occurs about half of this time, the mass generation rate for leather furniture spray can be calculated as 0.75 g/sec. and the spray duration as 3 minutes.
Based on the general composition, it is assumed that the non-volatile part in furniture polish spray is about 10 %; the default value weight fraction non-volatile is set at 0.1 g/g.

Default values leather furniture spray: spraying a leather sofa

	Default value	Q	References, comments
General			
Frequency	1 year^{-1}	2	See use
Inhalation			
Exposure, spray model			
Spray duration	3 min	2	See above
Exposure duration	240 min	3	Default
Room volume	58 m^3	4	Living room[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	0.5 h^{-1}	3	Living room[2)]
Mass generation rate	0.75 g/sec	3	See § 2.4.1
Airborne fraction	1 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.1 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	25 µm (0.4)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	100 mg/min	3	See § 2.4.2
Release duration	3 min	2	I.e. spray duration
Uptake			
Uptake fraction	1	2	Potential dose

9 Miscellaneous

Specialty cleaning products are designed for specific surfaces, such as glass, ovens, metal and drains. The applications of these products are described from section 9.1 up to section 9.4. In section 9.5, shoe polish products, i.e. shoe polish spray and shoe cream are described and in section 9.6, cleaners applied with in pressure washers.

9.1 Glass cleaners

Glass cleaners are being used for removing dirt, smoke deposit and fingerprints from windows, mirrors, glass cases and glass tables. They clean the area without stripes and they are generally used undiluted by means of a trigger spray.

Composition

General formula of glass cleaners[5,17,27)]

Glass cleaners	**Liquid spray %**
Surfactants	
Anionic surfactants	0 – 10
Non-ionic surfactants	0 - 5
Bases	0 – 5
Ammonia	
Solvents and hydrotopes	5 – 20
Alcohols, glycols or glycol ethers	
Additives:	< 1
Preservatives, perfume	
Water	75 - 95

For ingredients in glass cleaners, see section 1.5.

Use

Two tables standing in the living room are sprayed with a glass cleaner. One glass table has a size of 70 x 140 cm and the other one a size of 100 x 200 cm; thus, the target area of the two glass tables is estimated at 3 m^2. After spraying the tables are wiped with a dry towel.

Phase 1 application: spraying

Inhalation: spray model

- *Application duration*

For spraying the default value is 14.3 sec/m^2 (see subsection 2.4.1). Thus, for an area of 3 m^2 the spraying time is 43 sec or 0.7 min.

- *Weight fraction non-volatile*

Based on the general composition, it is assumed that the non-volatile part in glass cleaning sprays is about 5 %; the default value weight fraction non-volatile is set at 0.05 g/g.

Default values for glass cleaner: spraying

	Default value	Q	References, comments
General			
Frequency	365 year^{-1}	2	Estimate, 1 day^{-1}
Inhalation			
Exposure, spray model			
Spray duration	0.7 min	3	See above
Exposure duration	240 min	3	Default
Room volume	58 m^3	4	Living room[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	0.5 hr^{-1}	3	Living room[2)]
Mass generation rate	0.78 g/sec	3	See § 2.4.1
Airborne fraction	0.2 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.05 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	46 mg/min	3	See § 2.4.2
Release duration	0.7 min	3	I.e. spray duration
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

Phase 2 application: cleaning

Dermal exposure: instant application

- *Product amount*

The sprayed amount is the mass generation rate multiplied with the spraying time i.e. 0.78 g/s x 43 s = 33.5 g. The amount on the surface is estimated at 85 % of 33.5 g i.e. 28.5 gram. Worst-case is estimated that 1 % of the product amount contacts the skin i.e.0.29 g.

Dermal uptake: diffusion through skin

- *Exposure time*

For cleaning the default value is 110 sec/m^2 (see subsection 2.4.1). Thus, for an area of 3 m^2 the cleaning time is 330 sec or 5.5 min. The default for exposure time is set at 6 minutes.

Default values for glass cleaner: cleaning

	Default value	Q	References, comments
General			
Frequency	365 year^{-1}	2	Estimate, 1 day^{-1}
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.29 g	1	See above
Uptake, diffusion through skin			
Exposure time	6 min	3	See above

9.2 Oven cleaners

Oven cleaners are strong degreasers and they are suitable for removing sticked dirt of ovens, grills etc. Oven cleaners contain strong alkaline ingredients and therefore, they can be irritating and caustic. Strong alkali is necessary to remove burned-on soils. There are trigger sprays and spray cans. When using a spray can, foam is formed on the target area. The application of a trigger spray is described in this chapter.

Composition

General formula oven cleaners

	Liquid[5)] %	Foam spray can[27)] %
Surfactants: - anionic and non-ionic surfactants	1 – 15	
Builders: - NTA	0 – 15	
Bases: - caustic soda or caustic potash	1 – 15	1 – 5
Solvents:		
Glycols or glycol ethers	0 – 5	1 – 30
Mono-ethanolamine		0 – 5
Additives		
Thickening agents e.g. smectite		< 5
Perfume & dye	< 1	
Water	85 – 95	60 – 90
Propellants		< 10

For ingredients in oven cleaners, see section 1.5.

Use

The scenario describes the cleaning of a cold oven once a fortnight with a trigger spray. The oven, measuring 30 cm x 40 cm x 45 cm, has a surface area of 0.9 m^2. After spraying the oven door is closed and the product has to soak 30 minutes (product information). Then the

oven is wiped clean with a wet cloth or sponge and one has to rinse frequently. The product information recommends to wear long rubber gloves and to avoid contact with skin, eyes, mucous membranes and clothing. Not all users will do this, therefore is assumed that the user wears no gloves while cleaning the oven.

General

- *Frequency*

Using the data from Versar[26], a 75th percentile is estimated at 1.5 times a month. For the frequency of solvent-type cleaning fluids or degreasers, Weststat[25] gives a 75th percentile 12 times a year (N= 1104). According to Vollebregt et al.[5], oven cleaners are used once a week or once a fortnight. The default value is set at 26 times a year.

Phase 1 application: spraying

Inhalation: spray model

- *Spray duration*

Weerdesteijn et al.[12] found for an area of 60 x 60 cm a used amount of 3.35 g (S.D. 0.98) with a calculated 75th percentile of 4.016 g and a maximum amount of 4.8 g. As default value for cleaning the oven twice the maximum amount is taken i.e. 26.7 g/m^2; so, for an area of 0.9 m^2 an amount of 24 g is needed. The active spraying time is amount used divided by mass generation rate i.e. 24 g / 0.78 g/s = 30.8 sec = 0.5 min, which is set as default value for spray duration.

- *Weight fraction non-volatile*

It is assumed that oven cleaning trigger sprays have more or less the same composition as oven cleaning liquids which contain surfactants, builders and bases (0-15 %, see above). It is assumed that the non-volatile part in oven cleaners is about 10 %; the default value weight fraction non-volatile is set at 0.1 g/g.

Default values for oven cleaner, trigger spray: spraying

	Default value	Q	References, comments
General			
Frequency	26 $year^{-1}$	3	See above
Inhalation			
Exposure, spray model			
Spray duration	0.5 min	3	See above
Exposure duration	60 min	3	Estimate
Room volume	15 m^3	4	Kitchen[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	2.5 h^{-1}	3	Kitchen[2)]
Mass generation rate	0.78 g/sec	3	See § 2.4.1
Airborne fraction	0.2 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.1 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	100 µm (0.6)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	46 mg/min	3	See § 2.4.2
Release duration	0.5 min	3	I.e. spray duration
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

Phase 2 application: cleaning

Dermal exposure: instant application

- *Product amount*

The sprayed amount is 24 g (see above). The amount on the surface is estimated at 85 % of 24 g i.e. 20.4 gram. Worst-case is estimated that 1 % of the product amount contacts the skin i.e. 0.2 g.

Dermal uptake: diffusion through skin

- *Exposure time*

According to the AISE, the maximum use duration for cleaning a surface is 20 minutes, which is taken as default value.

Default values for oven cleaner, trigger spray: cleaning

	Default value	Q	References, comments
General			
Frequency	26 year^{-1}	3	See above
Dermal			
Exposure, instant application			
Exposed area	430 cm^2	3	One hand: ½ area hands[2)]
Product amount	0.20 g	1	See above
Uptake, diffusion through skin			
Exposure time	20 min	2	See above

9.3 Metal cleaners

Metal cleaners are used for cleaning, polishing, protecting and for restoring all kinds of metal such as chrome, copper, brass, aluminium and stainless steel. There are two types of products i.e. water based products and solvent-based products (see table below).

Composition

General formula of metal cleaners

Metal cleaners	Liquid water based[34)] %	Liquid solvent based[27)] %
Solvents		
Naphtha	31	60 - 70
Oleic acid	0.5	
Alkanolamine	0.2	
Bases or salts Ammonia or ammonium chloride	0.5	2 – 3
Additives		
Polishing agents e.g. silica	3.5	9 – 12
Water	64	

For ingredients in metal cleaners, see section 1.5.

Use

A small amount of metal cleaner is applied to a soft (damp) cloth. The metal is rubbed vigorously with straight, back-and-forth motions for a uniform appearance. To avoid reusing the dirty part, the cloth has to be turned frequently. Finally, the metal is polished with a clean dry cloth. In the kitchen, a stainless steal working top of 1.71 m^2 is cleaned every two months with 10 gram metal cleaner.

Exposure

Inhalation: evaporation from increasing area

- *Molecular weight matrix*

Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol (see subsection 2.2.2).

Default values for metal cleaners: cleaning

	Default value	Q	References, comments
General			
Frequency	6 $year^{-1}$	2	See above
Inhalation			
Exposure, evaporation from increasing area			
Exposure duration	60 min	3	Estimate
Product amount	10 g	2	See above
Room volume	15 m^3	4	Kitchen[2)]
Ventilation rate	2.5 hr^{-1}	3	Kitchen[2)]
Release area	1.71 m^2	3	See above
Application duration	10 min	2	Estimate
Temperature	20 °C	4	Room temperature
Mass transfer rate	Langmuir's method		See help-file ConsExpo
Mol. weight matrix	22 g/mol	2	See above
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: ¼ area hands[2)]
Product amount	0.10 g	1	1% of 10 g product; see § 2.3
Uptake, diffusion through skin			
Exposure time	10 min	2	I.e. application duration

9.4 Drain openers

Drain openers open slow running and obstructed drains by dissolving and by loosening grease and organic waste. There are different kinds of drain openers, products containing either sodium hydroxide (caustic soda or caustic liquid) or sulphuric acid. Both products are corrosive. The composition of these products is given in the table below.
There are also drain openers containing beneficial bacteria of the Bacillus species. To eliminate clogs, pollution and odours these bacteria break down and convert organic material into its two most basic components i.e. carbon dioxide and water. Free enzymes are added to the formula to break up complex waste molecules into small, simple pieces that can be digested directly by the bacteria[36)]. Products containing bacteria are not discussed in this fact sheet.

Composition

General formula of drain openers

Drain openers	**Liquid A**[27, c)] **%**	**Liquid B**[b,c)] **%**	**Solid, pellets %**
Alkaline: Sodium hydroxide		15 – 30	100
Acid: Sulphuric acid [a)]	98		
Aluminium			< 1
Water	< 2	70 – 85	

[a)] predominantly used by professionals
[b)] information manufacturers
[c)] information from the Dutch Association for Soap Manufacturers (NVZ), January 2004

For ingredients in drain openers, see section 1.5.

Use
The use of *liquid* drain openers is comparable with the loading of liquid cleaners. The drain opener must be loaded slowly down the drain. One has to wait at least 15 minutes so that the drain opener can clear the blockage. One directions for use stated that the whole content from the bottle (500 ml) should be used in the case of wholly or partly blocked drains. These products are corrosive and therefore, hands and eyes must be protected. In this default, the assumption is that the consumer does not use gloves. There could be dermal contact with the product, if droplets liquid caustic soda or sulphuric acid spatter on the skin.

Exposure
Although the amount for filling the drain with liquid drain opener is larger than the used amount of an all-purpose cleaner, no distinction is made between mixing and loading a liquid drain opener (500 g; density 1 g/cm^3) and an all-purpose cleaner (63 g). The default values for mixing and loading all-purpose cleaner, liquid (see section 5.2) can be used. For estimating the 75th percentile of the frequency, data from Versar[26)] is used i.e.
2 times per 6 month or 4 year^{-1} (Q=2).

9.5 Shoe polish products

For keeping shoes in good repair, one uses shoe polish. The ingredients such as waxes are for protecting and for nourishing leather and they produce al long-lasting glossy shine. In this section, shoe polish spray and shoe polish cream are described in subsection 9.5.1 and 9.5.2, respectively.

Composition

A formula for shoe polish products

Shoe polish products	**Spray**[27] **%**	**Cream**[27] **%**
Waxes	< 5	40- 50
Turpentine oil	22	< 10
Solvents: Naphtha	20	< 5
Additives		
Dye	0.2 – 0.5	0.2 – 0.5
Water	+	+
Propellants	< 18	

+: ingredient in shoe polish products

For ingredients in shoe polish products, see section 1.5.

9.5.1 Shoe polish spray

Use

The scenario describes the spraying of 4 pair of shoes which is done in the garage. The area that will not have to be dyed must be masked off and the shoes must be sprayed with several very light coatings. Between the applications the dye must be dried well. When the shoes are completely dry, they are ready for wearing. The shoes are not polished up.

General

- *Frequency*

For the frequency of spray shoe polish, Weststat[25] gives a 75th percentile of 8 times a year (N = 1390). The mean number of uses is 10.3 times a year (S.D. 20.1; N = 266) and the median is 4 times a year. For frequency, the default value is set at 8 times a year.

Inhalation: spray model

- *Mass generation rate*

The default value for the mass generation rate of sprays is 1.5 g/s (see subsection 2.4.1). It is assumed that the use duration, the time during which the spraying takes place, is three times as long as the actual spraying time. The mass generation rate is set at 0.5 g/s.

- *Spray duration*

Weststat[25] gives a 75th percentile of 284 g for used amount per year i.e. a used amount of 36 gram per event. With a mass generation rate of 0.5 g/s, the calculated spray duration is 72 sec or 1.2 min. The latter is set as default value.

- *Weight fraction non-volatile*

Based on the general composition, it is assumed that the non-volatile part in shoe polish sprays is about 5 %; the default value weight fraction non-volatile is set at 0.05 g/g.

Default values for shoe polish spray

	Default value	Q	References, comments
General			
Frequency	8 $year^{-1}$	3	See above
Inhalation			
Exposure, spray model			
Spray duration	1.2 min	3	See above
Exposure duration	5 min	2	Estimate
Room volume	34 m^3	3	Garage[2)]
Room height	2.5 m	4	Standard room height
Ventilation rate	1.5 h^{-1}	3	Garage[2)]
Mass generation rate	0.5 g/sec	3	See above
Airborne fraction	1 g/g	2	See § 2.4.1
Weight fraction non-volatile	0.05 g/g	2	See above
Density non-volatile	1.8 g/cm^3	3	See § 2.4.1
Initial particle distribution			
Median (C.V.)	25 µm (0.4)	3	See § 2.4.1
Inhalation cut-off diameter	15 µm		See § 2.4.1
Uptake			
Uptake fraction	1	2	Potential dose
Inhalation rate	24.1 L/min	3	Light exercise[22)]
Non-respirable (oral) uptake			
Oral uptake fraction	1	2	Potential dose
Dermal			
Exposure, constant rate			
Contact rate	100 mg/min	3	See § 2.4.2
Release duration	1.2 min	3	I.e. spray duration
Uptake, fixed fraction			
Uptake fraction	1	2	Potential dose

9.5.2 Shoe cream

Use

The scenario describes the polishing of 4 pair of shoes i.e. 0.3 m^2 of leather with 10 gram of shoe cream. The shoe polish coming from a jar is applied with an applicator brush or with a soft cloth on the leather. After drying for 10 minutes the shoes are brushed with a shoe brush and finally, they are buffed briskly with a shine cloth. During applying and during polishing, there could be dermal exposure.

General

- *Frequency*

The frequency is estimated at once a fortnight i.e. 26 times a year. It is assumed that one uses shoe polish cream more frequently than shoe polish spray. For shoe polish *spray*, Weststat[25)] gives a 90th percentile of 24 times a year. The default value is set at 26 $year^{-1}$.

Default values for shoe cream

	Default value	Q	References, comments
General			
Frequency	26 year^{-1}	3	See above
Dermal			
Exposure, instant application			
Exposed area	215 cm^2	3	One palm: 0.25 area hands[2)]
Product amount	0.10 g	1	1% of 10 g product: see § 2.3
Uptake, diffusion through skin			
Exposure time	20 min	2	Estimate

9.6 Pressure washers

There are pressure washers (high-pressure sprayers) for private use and for commercial use. The former is described in this section. The principle of pressure washers is that a pump compresses water from water sources such as the water residential supply, a rain barrel or a ditch. Then water becomes pressurised and finally it is drained off through a small nozzle at the end of a trigger-actuated wand. Pressure washers are applied among other things for cleaning terraces, cars or the outside of the house.
They are rated at the maximum pressure the pump generates and the amount of water the pump moves in litres per hour. It is the pressure that breaks the dirt away and the volume of water that determines the appliance's ability to flush the dirt away. Manufacturers use the term 'cleaning units' i.e. water pressure multiplied by water volume, to express washer effectiveness[39)]. Spray shape influences the performance too; most pressure sprays have an adjustable nozzle delivering either a continuous range from a pencil-thin jet or a wide fanlike spray. The variables pressure, water volume, spray shape and also the distance from the spray tip to the surface affect the time it takes to get the job done[38, 39)]. For persistent dirt and soil on large surface areas, it is feasible to use a rotary spray or turbo nozzle which distributes the narrow jet over a wider area. This enhances greatly the cleaning performance[38, 39)].
For removing dirt with a detergent, pressure sprays draw (diluted) liquid detergent through a siphon over system. During the cleaning with detergent the pressure should be relatively low. The reservoir with detergent can either be built-in or standing apart. Pressure washers may have a dedicated detergent-dispensing nozzle and a small container. In the device detergent and water are mixed and through the nozzle the diluted detergent is drained off.
The working pressure of pressure washers ranges from 100 to 125 bar and for the expensive devices the pressure can be adjusted from 20 bar to the maximum pressure. The water capacity ranges from 300 to 550 L hr^{-1} [40)].

Use
The scenario describes the cleaning of a terrace. A pressure washer is used with a water capacity of 400 L hr^{-1} and a working pressure of minimal 20 bars. Further, as detergent a ready-to-use solution is poured into the detergent tank. The spraying is done once a month; the effective use duration of spraying with a detergent is 30 minutes.
In ConsExpo there is no model appropriate for this type of spraying; furthermore, ConsExpo is developed for products applied indoors. Models describing the manual spraying of

pesticides are not applicable, as the pressure of pressure washers is much higher than that of manual spraying. Because pressure washers are normally used on hard surfaces with high pressure, the bounce back effects will be important for the exposure.
In the Technical Notes for Guidance, human exposure to biocidal products (TNsG)[41] an empirical model is described which includes high-pressure hosing. In the TNsG a spray application for biocides is described; it regards a very 'wide' model. The top end of the model represents contamination rates arising from use of high pressure hosing of large areas and the operators became visibly drenched over a period of time. For the application of pressure washers, the 95th percentile values from this model seem applicable as an indication for the dermal and inhalation exposure. For application inclusive mixing and loading, the indicative surrogate values are for:

- inhalation exposure: 198 mg spray liquid per m^3 [41]
- dermal exposure: 2100 mg spray liquid per minute[41]

These values are indicative because the TNsG describes the model summarily; further, the model is devised for principally professionals, whereas in this fact sheet the consumer's exposure is described.

Exposure

- *Frequency*

It is assumed that once a month the pressure washer is used.

- *Spray duration*

The effective spraying time is set at 30 minutes.

Inhalation exposure

The indicative surrogate value is 198 mg spray liquid per m^3 (see above). In the pressure washer detergent is automatically mixed with water; sometimes the amount of detergent is adjustable. Generally a fixed amount is mixed with water, which is about 3%[40].
The surrogate value becomes 0.03 x 198 = 5.9 mg detergent per m^3.
The inhalation exposure is calculated as amount detergent/m^3 x inhalation rate x use duration.
The inhalation rate is 24.1 x 10^{-3} m^3 /min[22] and the use duration is 30 minutes per event which gives an inhalation exposure of 5.9 x 24.1 x 10^{-3} x 30 = 4.3 mg detergent per event.

Dermal exposure

The indicative surrogate value is 2100 mg spray liquid /min (see above); 3 % detergent[40] is mixed with water. The surrogate value becomes 0.03 x 2100 = 63 mg detergent per min.
The dermal exposure is calculated as amount detergent / min x application duration (min/ event) which gives an exposure of 63 x 30 = 1890 mg detergent per event.

References

1 Delmaar, J.E., M.V.D.Z. Park, J.G.M. van Engelen, 2005
ConsExpo 4.0, Consumer Exposure and Uptake Models. Program Manuel. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 320104004

2 Bremmer, H.J., L.C.H. Prud'homme de Lodder, J.G.M. van Engelen, 2005
Fact Sheet General. To assess the risks for the consumer. Updated version for ConsExpo 4. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 320104002

3 Davis, G.A, Ph., D. Dickey, B. Duxbury, B.Griffith, B.Oakley, K.Cornell, 1992
Household cleaners: Environmental evaluation and proprosed standards for general purpose household cleaners. University of Tennesse, Center for Clean Products and Clean Technologies.

4 Falbe, J. (editor), 1987
Surfactants in consumer products: Theory, Technology and Application; Springer, Berlin

5 Vollebregt, L., R. de Mooy, P. van Broekhuizen, 1994
De grote schoonmaak: totaal vernieuwd. Amsterdam: Chemiewinkel UvA.

6 Wark, K and C.F.Warner, 1981
Air pollution: its Origin and Control

7 Plassche E.J. van de, P.H.F. Bont, J.M.Hesse, 1999
Exploratory Report on Fluorescent Whitening Agents (FWAs). Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 601503013

8 Biocides Steering Group, 1998
Assessment of Human Exposures to Biocides. Report to DG XI from the Biocides Steering Group. TNO Zeist: project 97/505/3040/DEB/E2

9 Bremmer, H.J., M.P. van Veen , 2000
Paint Fact Sheet. To assess the risks for the consumer (in Dutch). Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 612810010

10 Weegels, M.F., 1997
Exposure to chemicals in consumer product use. Faculty of Industrial Design Engineering, Delft University of Technology, The Netherlands.

11 European Communities, 2003
Technical guidance documents on Risk Assessment in support of Commission directive 93/67/EEC on risk assesment for new notified substances; Commission regulation (EC) no 1488/94 on risk assesment for existing substances; Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market

12 Weerdesteijn, M.C.H., H.J. Bremmer, M.J. Zeilmaker, and M.P. van Veen, 1999
Hygienic Cleaning Products Used in the Kitchen. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no.612810008

13 Bremmer, H.J., L.C.H. Prud'homme de Lodder, W.M. Blom, P.H. van Hoeven-Arentzen, M.T.M. van Raaij, E.H.F.M. Straetmans, M.P. van Veen, J.G.M. van Engelen, 2005
Pest Control Products Fact Sheet. To assess the risks for the consumer. Updated version for ConsExpo 4. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 320005002

14 Straetmans, E.H.F.M., 2000
Blootstelling van de consument aan biociden tijdens en na spray-toepassing. RIVM, report on period of work experience.

15 Dutch Aerosol Association (NAV), 1995
Guide to Spray Cans (in Dutch)

16 Matoba Y., J. Ohnishi, M. Matsuo, 1993
A simulation of insecticides in indoor aerosol space spraying. Chemosphere 26, 1167-1186

17 Vollebregt, L., P. van Broekhuizen, 1994.
Tussen wasmand en afdruiprek. Amsterdam: Chemiewinkel UvA.

18 US EPA, 1989.
Environmental releases of chemicals in household products. Springfield: Versar Inc.

19 Engelen, J.G.M. van, L.C.H. Prud'homme de Lodder, 2004
Non-food products: How to assess children's exposure? Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 320005001.

20 AISE: International Association for Soaps, Detergents and Maintenance Products, 2002.
Hera project: Table of habits and practices for consumer products in Western Europe.

21 Prud'homme de Lodder, L.C.H., H.J. Bremmer, 2001
Practical research cosmetics, internal RIVM note

22 Freijer, J.I., H.J.Th. Bloemen, S. de Loos, M.Marra, J.J.A. Rombout, G.M. Steentjes, M.P. van Veen, 1997.
AirPEx: Air Pollution Exposure Model. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 650010005

23 Rodriguez, C., G. Calvin, C. Lally, and J.M. Lachapelle, 1994
Skin effect associated with wearing fabrics washed with wearing fabrics washed with commercial laundry detergents. Journal of toxicology- cutaneous and ocular toxicology, 1994 (13) 39-45

24 HERA, 2002
Human & Environmental Risk Assessment on ingredients of European household cleaning products: Alcohol Sulphates, draft. www.heraproject.com

25 Weststat Inc., 1987
Household Solvent Products: A National Usage Survey. EPA-OTS 560/5-87-005

26 Versar Inc., 1992
FLUSH User's Manual. U.S.E.P.A. Contract. No 68-D9_0166

27 Household Products Database, National Institute of Health and U.S. National Library of Medicine http://hpd.nlm.nih.gov/products.htm

28 Smit, D., P. Visser, 1987.
Inventarisatie Reinigingsmiddelen: eindrapport. Amsterdam: MILAD

29 Siderius, P.J.S., N. van Haaren, 1992.
Huishoudelijke schoonmaakmiddelen onder de loep. SWOKA

30 Lever Fabergé Nederland BV, 2000
Vaatwasmiddelen. http://www.leverfaberge.nl/wist/pdf's/vaatwasmiddelen.pdf

31 Lever Fabergé Nederland BV, 2002
Reinigingsmiddelen. http://www.leverfaberge.nl/wist/pdf's/reinigingsmiddelen.pdf

32 NVZ: Dutch Association for Soap Manufacturers, 2004
www.isditproductveilig.nl

33 The Soap and Detergent Association (SDA) www.cleaning101.com

34 Edel, L.P., 1936
Mengen en Roeren deel 1, 2000 Populaire chemische recepten voor iedereen. Kluwer, 9e druk

35 Snippe, R.J., Van Drooge, H.L., Schipper, H.J., De Pater, A.J., Van Hemmen, J.J., 2002.
Pesticide exposure assessment for registration purposes. Version 2002. TNO Voeding, Zeist, Nederland, TNO report V3642.

36 http://www.colehardware.com/: drain openers

37 Van Golstein Brouwers, Y.G.C., J. Marquart, J.J. van Hemmen, 1996
Assessment of occupational exposure to pesticides in agriculture. Part IV: Protocol for the use of genric exposure data. TNO-report V 96.120

38 Crauwels, T. and R.Vanparys, 2004
Hogedrukreinigers, Schoonmaker blijf bij je leest. Test-aankoop nr.474, March 2004
http://www.karcher.be/pics/testaankoop_NL.pdf

39 Klenck, T., 2003
PM Comparison Test: 6 Electric Pressure Washers.
http://www.azcentral.com/home/diy/pressure.html

40 www.karcher.com and personal communication Kärcher Holland, March 2004

41 European Commission DG Environment, 2002
Technical Notes for Guidance: Human exposure to biocidal products, Guidance on exposure estimation. Report prepared under contract B4-3040/2000/291079/MAR/E2

42 Tuinman, I.L., 2005
Aerosols from spray cans and trigger sprays. Particle size distributions and spreading in a closed environment. TNO report PML 2004-C106

43 PSD, Pesticides Safety Directorate, 2003
Revised UK Predictive Operator Exposure Model (POEM): Estimation of Exposure and Absorption of Pesticides by Spray Operators, UK Scientific Subcommittee on Pesticides & British Agrochemical Association Joint Medical Panel.

44 Thompson, J., M.Roff, 1996
Dermal exposure of occasional users of pesticide products: flea spray in aerosol cans. Sheffield, UK: Health and Safety Laboratory. Report IR/A/96/10

45 Bremmer, H.J. and M.P. van Veen, 2002
Children's Toys Fact Sheet. Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM). Report no. 612810 012.

46 Ochoa, H.G., B.K.-M. Gadagbui, S. Roy, J.K. Tolson, S.M. Roberts, 2003
Technical Report: Development of Cleanup Target Levels (CTLs for Chapter 62-777, F.A.C. (Draft). University of Florida

47 U.S. Environmental Protection Agency, 1997.
Standard Operating Procedures (SOPs) for Residential Exposure Assessments (Draft). Contract No. 68-W6-0030, Work Assignment No. 3385.102. Prepared by: The Residential Exposure Assessment Work Group. Includes: Office of Pesticide Program, Health Effects Division, Versar Inc.

48 U.S. Environmental Protection Agency, 1997.
Exposure Factors Handbook, Volume 3: Activity Factors. EPA/600/P-95/002 Fa.
www.epa.gov/ncea/pdfs/efh/front.pdf

49 Delmaar et al.(in prep.)
ConsExpo 4 Spray Model. Description and Experimental Validation.
Bilthoven, The Netherlands: National Institute for Public Health and the Environment (RIVM).