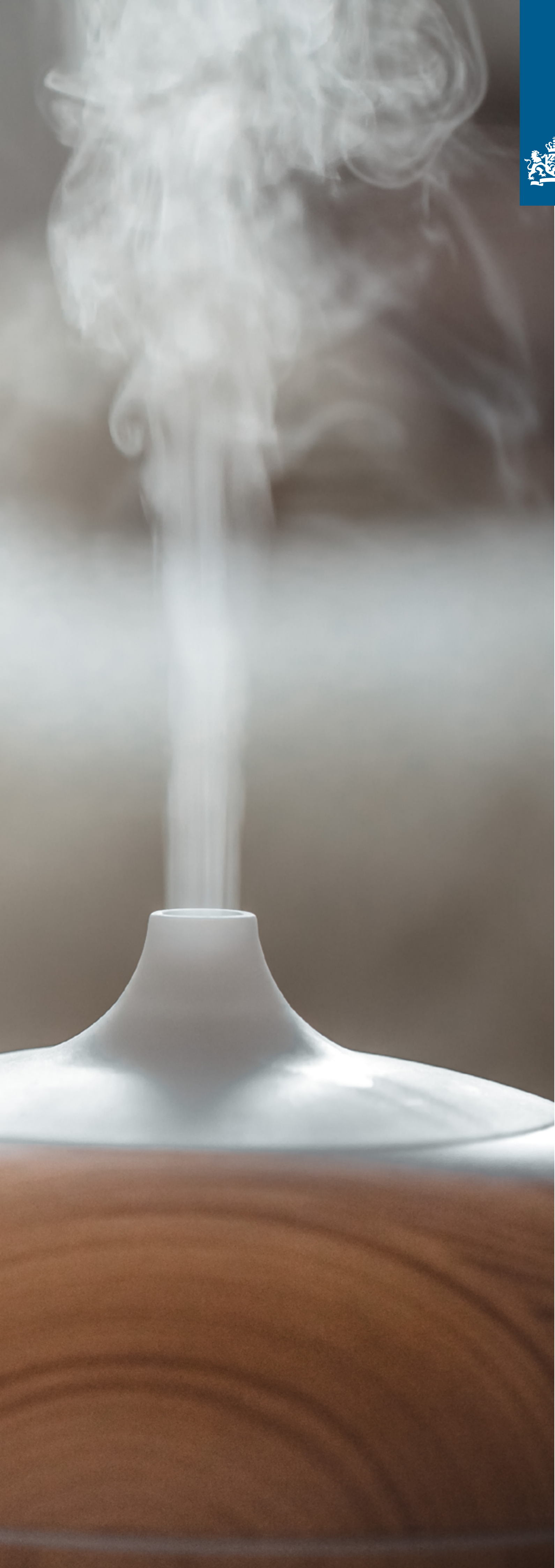

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

Air Fresheners Fact Sheet

Default parameters for estimating consumer exposure – Version 2021

ConsExpo
consumer | exposure

National Institute for Public Health
and the Environment
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Air Fresheners Fact Sheet

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RIVM report 2021-0233

Colophon

RIVM attaches a great deal of importance to the accessibility of its products. However, it is at present not yet possible to provide this document in a completely accessible form. If a part is not accessible, it is mentioned as such. Also see www.rivm.nl/en/accessibility

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Synopsis

Air Fresheners Fact Sheet
Default parameters for estimating consumer exposure

Accurate estimation of consumer exposure is a necessity in assessing the risks of potential harm from chemical substances in consumer products. RIVM has developed a web-based computer model called ConsExpo Web to estimate such exposure. ConsExpo Web can be used to calculate indoor consumer exposure to chemical substances during the use of for example paint, cleaning products and personal care products.

Fact Sheets have been written that address default models and default parameter values, so that users of ConsExpo Web are able to perform exposure assessment in a standardised and transparent way. Several Fact Sheets are already available. The Air Fresheners Fact Sheet adds to this series.

The Air Fresheners Fact Sheet describes default parameters values useful in estimating exposure to chemical substances in air freshener products, such as values for frequency of use and product amount. The Air Fresheners Fact Sheet also describes the available data sources and the sources consulted, how these were evaluated and how the default parameters values are derived.

The new defaults for air fresheners used at home – in living areas and in toilet rooms – and in cars, as well as for fabric fresheners and animal odour mask products, are uploaded into the ConsExpo database to coincide with the publication of this Air Fresheners Fact Sheet.

Keywords: ConsExpo Web, Fact Sheet, standardisation, consumer exposure estimation, air fresheners

Publiekssamenvatting

Luchtverfrissers Factsheet
Standaard parameters voor de schatting van consumentenblootstelling

Chemische stoffen in consumentenproducten kunnen risico's hebben voor de gebruiker. Om die te kunnen beoordelen, is een goede schatting nodig van de mate waarin de gebruiker blootstaat aan chemische stoffen. Voor deze schatting heeft het RIVM het computerprogramma ConsExpo ontwikkeld. Hiermee kan bijvoorbeeld worden berekend in welke mate iemand tijdens het gebruik in huis van bijvoorbeeld verf, schoonmaakmiddelen of cosmetica, aan een chemische stof blootstaat.

Voor de gebruikers van ConsExpo Web maakt het RIVM Factsheets waarin standaardmodellen en standaardwaarden (defaults) staan beschreven. Door deze modellen en waarden te gebruiken, wordt de blootstelling op een transparante en gestandaardiseerde manier geschat. Er zijn meerdere Factsheets, waaraan nu de Factsheet over luchtverfrissers is toegevoegd. Het gaat onder andere over luchtverfrissersprays, elektrische verdampers, en middelen om nare luchtjes te maskeren en uit kleding te verwijderen.

Voorbeelden van standaardwaarden voor luchtverfrissers zijn hoe vaak in en in welke hoeveelheden het product gebruikt wordt. Ook worden de onderliggende databronnen in de Factsheet beschreven en beoordeeld op kwaliteit. Op basis daarvan zijn de standaardwaarden bepaald. De kwaliteit van de data wordt beoordeeld met een cijfer (kwaliteitsfactor). De standaardwaarden en -modellen uit deze Factsheet worden ook aan de ConsExpo Web-database toegevoegd.

Kernwoorden: ConsExpo Web, Factsheet, standaardisering, consumentenblootstellingsschatting, luchtverfrissers

Contents

Summary

The aim of the current report is to give guidance in the assessment of consumer exposure to chemical substances in air freshener products. The report describes the default scenario and parameter values applied in the ConsExpo model. ConsExpo is used to calculate consumer exposure to chemicals in consumer products via different exposure routes. The values given in this Air Fresheners Fact Sheet have been added to a database coupled to ConsExpo, which was developed by the RIVM in the early 1990s. ConsExpo is now used by various (inter)national bodies and within different legal frameworks. An online version of ConsExpo (ConsExpo Web) was launched in 2016.

Product-specific default values are important for the consistent and harmonised estimation and assessment of consumer exposure to chemical substances contained in consumer products. These are developed for different product categories and described in a series of specific Fact Sheets, which provide consumer exposure scenarios for the use of cleaning products, cosmetics, paint products, pest control products, disinfectant products, do-it-yourself products and children's toys. In addition, the General Fact Sheet (of which the most recent update was published in 2014 by Te Biesebeek et al.) describes generic defaults for consumer exposure estimation such as body weight, surface areas of body parts, room sizes and ventilation rates. The current report is the first version of the Air Fresheners Fact Sheet.

Although ConsExpo was originally developed for the Dutch consumer market, the default parameter values assigned are now aimed at consumers in general. The data drawn from international studies supporting the prescribed defaults are explained and their quality and reliability evaluated. The default values and scenarios have been added to the ConsExpo database in parallel to publication of this Fact Sheet.

The Air Fresheners Fact Sheet explains standardised approaches in exposure estimation for every air freshener product use activity from which consumer exposure is anticipated. Scenarios are drawn that explicitly explain how the consumer exposure is anticipated from intentional product use. The most suitable consumer exposure models are assigned to each scenario including default parameter values for the input fields of the models. Detailed information is given on the derivation, motivation and underlying data to underpin the described consumer exposure scenarios, default models and parameter values. This Air Freshener Fact Sheet includes defaults for the estimation of exposure to substances in home air fresheners, toilet air fresheners, car air fresheners, fabric fresheners and animal odour mask products.

The quality of the supporting data is ranked and a rationale is provided for all of the selected defaults. The data sources that are referred to most frequently in the current Fact Sheet are summarised in a separate chapter.

Samenvatting

Het doel van deze Luchtverfrissers Factsheet is om ondersteuning te bieden in de beoordeling van blootstelling aan stoffen die consumenten ondervinden bij het gebruik van luchtverfrissers.

Het rapport is de eerste versie van het factsheet voor luchtverfrissers waarin standaard blootstellingsscenario's en standaardwaarden (defaults) staan beschreven voor het maken van een consumentenblootstellingschatting aan stoffen in luchtverfrissers. Deze defaults zijn toepasbaar in de ConsExpo software, dat consumentenblootstelling aan chemische stoffen in consumentenproducten via de verschillende blootstellingsroutes kan berekenen. De waarden beschreven in de Luchtverfrissers Factsheet zijn recentelijk toegevoegd aan een database die is gekoppeld aan ConsExpo, een software model dat is ontwikkeld in het begin van de jaren negentig. ConsExpo wordt gebruikt door diverse (inter)nationale organisaties en binnen verschillende wettelijke kaders. In het jaar 2016 is een online versie beschikbaar gekomen, ConsExpo Web.

Productspecifieke defaults zijn essentiële waarden voor een consistente en geharmoniseerde bepaling en beoordeling van de blootstelling aan stoffen in consumentenproducten bij het gebruik van ConsExpo. Deze defaults zijn ontwikkeld voor de verschillende productcategorieën en beschreven in een reeks van specifieke factsheets met blootstellingscenario's voor het gebruik van schoonmaakmiddelen, cosmetica, verfproducten, ongediertebestrijdingsmiddelen, desinfecterende middelen, doe-het- zelfproducten en speelgoed. Daarnaast staan defaults voor generieke parameters zoals lichaamsgewicht, lichaamsoppervlak, kamergrootte en ventilatievoud beschreven in de Factsheet Algemeen, waarvan de meeste recente versie in 2014 is verschenen (Te Biesebeek et al. 2014).

Het huidige Luchtverfrissers Factsheet rapport is toegevoegd aan de bestaande serie aan factsheets. De data en de defaults zijn zoveel mogelijk gebaseerd op de Nederlandse situatie. Bij afwezigheid van geschikte Nederlandse data is er gebruik gemaakt van informatie uit andere landen. De onderliggende databronnen die gebruikt zijn voor het verkrijgen van de defaults worden uitgelegd en de betrouwbaarheid van de defaults wordt verantwoord met informatie over hun kwaliteit. Parallel aan het publiceren van deze factsheet, zijn ook de waarden aan de ConsExpo database worden toegevoegd.

De Luchtverfrissers Factsheet geeft gedetailleerde informatie en de blootstellingscenario's bij productgebruik staan expliciet beschreven. Voor elke mogelijke gebruikersactiviteit die kan leiden tot blootstelling zijn gestandaardiseerde waarden voorgeschreven. Dat houdt tevens in dat er specifieke modellen en defaults voor modelparameters staan voorgeschreven voor de blootstellingsschatting van stoffen in verschillende productgroepen van luchtverfrissers die worden gebruikt door het hele huis, het toilet, de auto of om nare geurtjes te maskeren

en neutraliseren uit textiel, of om geurtjes afkomstig van huisdieren te maskeren en neutraliseren. Alle defaults zijn voorzien van een rationale en een kwaliteitscore voor de onderliggende data. De databronnen waar het meest naar gerefereerd wordt staan samengevat beschreven in een apart hoofdstuk.

1 Introduction

1.1 Background

The ConsExpo software was developed in the early nineties at the request of the Keuringsdienst van Waren (currently Netherlands Food and Consumer Product Safety Authority; NVWA) and the Ministry of Health, Welfare and Sport (VWS) to calculate human exposure to chemicals in non-food consumer products. ConsExpo was designed and is used to estimate consumer exposure via all exposure routes (inhalation, dermal and oral exposure). Over the years, the ConsExpo project has been extended by the development of Fact Sheets, which are incorporated into the ConsExpo software as a database.

The Fact Sheets are documents containing exposure scenarios and default values for various product categories (Bremmer & Van Veen, 2002; Bremmer et al., 2006a, 2006b; Prud'homme de Lodder et al., 2006a, 2006b; Bremmer & Van Engelen 2007; Ter Burg et al., 2007; Meesters et al., 2018). In addition, there is a General Fact Sheet containing default values for parameters such as body weight, skin surface area, room volume, ventilation rate and activity patterns (Te Biesebeek et al., 2014). The defaults described in the various Fact Sheets ensure that exposure assessments are conducted in a harmonised and standardised way, providing reasonable worst-case estimates, and are fit for use in the ConsExpo Web software.

1.2 ConsExpo Web

In October 2016, ConsExpo Web was launched as a web tool (www.consexpoweb.nl) for estimating exposure to chemical substances in consumer products. The online tool is open for any future updates that improve the model. ConsExpo Web allows the user to include multiple scenarios within a single assessment. A new high-tier model has been added to assess exposure to emissions from solid products (or articles), and a first-tier, screening-level (sub)model for estimating exposure to non-volatile substances in sprays has been added to the 'exposure to spray' model. A batch assessment functionality has been introduced to perform exposure evaluations for groups of substances, populations, products and/or scenarios in one run (Minnema et al., 2021). Finally, the terminology for the outputs has been updated and the calculated exposure metrics have been adjusted. An updated manual describing how to use ConsExpo Web, as well as a description of the models available in the software, is available (Delmaar & Schuur, 2017).

The use of ConsExpo is recommended for consumer exposure assessment under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation (EC, 2006) and the model is described in the updated REACH guidance (ECHA, 2016). It is also one of the models recommended for the assessment of consumer exposure to biocides (EC, 2012; ECHA, 2015a, 2015b).

ConsExpo Web has been developed as an online software tool for the assessment of exposure to substances in consumer products. For this purpose, the software contains a set of coherent general mathematical models. Consumer exposure can be estimated by choosing the most suitable model and filling in the required parameters of the product, such as the amount used or concentration of the substance within a product, consistent with the scenario.

ConsExpo is constructed using data on the use of products contained in the Fact Sheets, which are then combined with mathematical models. The program is based on relatively simple exposure models. The starting point for these models is the route of exposure, i.e. inhalation, dermal or oral. The most appropriate exposure scenario and model is chosen for each route. Then, parameters needed for the exposure scenario and model, such as substance-specific data and the frequency and duration of use, are entered into the ConsExpo software for calculation of the exposure. Further details of the mathematics behind ConsExpo are described in the manual (Delmaar & Schuur, 2017).

ConsExpo can be used for a screening assessment (lower-tier, often used in regulatory frameworks) or for an advanced (higher-tier) assessment. For different exposure situations, different models are provided for calculating exposure. ConsExpo also integrates the exposure via the different routes, resulting in a systemic dose. Different dosing regimens/exposure situations can be calculated (acute, daily, chronic). ConsExpo can also run calculations using distributed input parameters and perform sensitivity analyses. The models per route of exposure included in ConsExpo have different levels of detail and complexity.

The ConsExpo tool is publicly available via www.consexpoweb.nl. Default data are available via the database, which is an integral part of the online tool. The manual and the various Fact Sheets can be consulted by following links to the website of the National Institute for Public Health and the Environment in the Netherlands (RIVM; www.rivm.nl/consexpo).

1.3 Fact Sheets

Fact Sheets are documents that present key information for the consistent and harmonised estimation and assessment of exposure to substances in consumer products when using ConsExpo. In the Fact Sheets, information about exposure to chemical substances is bundled into certain product or exposure categories, and default parameters are given. The main product categories, i.e. groupings of similar products, are defined in the ConsExpo database. Examples of these categories are cleaning products, paint, cosmetics, toys and pest control products. Categories are structured in such a way that products to which consumer exposure is similar are covered by one scenario. The choice of main product categories and subcategories is based on the product classifications used under REACH, by the United States Environmental Protection Agency (US-EPA) and by the Swedish Chemical Agency (KEMI), as described by the Organisation for Economic Co-operation and Development (OECD, 2012).

The Fact Sheets have been developed in order to characterise and standardise the exposure estimation in combination with the ConsExpo software, but they are also useful for any exposure estimation carried out without the use of the software. For each product category the composition and use of the type of products included in that category are described. To estimate exposure, default models with default parameter values are determined for each product category. These are available via a database included in ConsExpo Web. Using these data, standardised calculations for consumer exposure to chemicals resulting from, for instance, the use of cleaning products can be performed. Fact Sheets for the product categories listed in Table 1.1 are currently available. In the near future, more Fact Sheets may be generated to cover other categories of consumer products.

Table 1.1 Main categories of consumer products, for which Fact Sheets are available.

Main categories of consumer products
Air fresheners
Children's toys
Cleaning products
Cosmetics
Disinfectants
Do-it-yourself products
Paint
Pest control products

Main product categories are divided into subcategories. For example, the main product category Cosmetics includes the following product subcategories: shampoo, make-up, lipstick, toothpaste and deodorant. Composition and use are examined for every product subcategory and, to estimate consumer exposure to substances, default models with default parameter values are determined for every product subcategory.

Scoping literature reviews (e.g. Arksey & O'Malley, 2005) are performed in order to collect the most appropriate data available to include in the Fact Sheets. The Fact Sheets therefore provide general background information on the exposure models. They also describe various exposure scenarios for the specific products and set defaults for relevant exposure parameters. The default values are presented as deterministic values, but the statistical information is also provided if possible. This can be used in distributions in probabilistic (aggregate) exposure assessments.

In general, the following topics are dealt with in the Fact Sheets:

- Background information about the main category that is relevant to exposure calculations.
- Delimitation of the main category and description of the product subcategories.

The Fact Sheets contain:

- general description of the product category;
- description of the composition of the products;
- description of the use of the products;
- remarks about the products;
- information on potentially problematic substances;
- default scenarios and models;
- default parameter values for the scenarios and models;
- considerations that have been made in calculating the defaults.

The General Fact Sheet (Te Biesebeek et al., 2014) gives general information about the Fact Sheets and deals with overarching topics that are relevant to several main product categories, such as:

- the boundary conditions under which the defaults are estimated;
- the way in which the reliability of data is evaluated;
- parameters such as ventilation rate and room size;
- anthropometric parameters such as body weight and the surface area of the human body, or parts thereof, and inhalation rates and activity patterns.

The default values from the General Fact Sheet are used in the specific Fact Sheets unless there are more profound or suitable data to define individualised values for the separate scenarios.

2 Default setting and quality of the data

The underlying data used to estimate consumer exposure in the default scenarios described in the Fact Sheets are collected from scientific literature, product information, legislation documents, survey data on consumer habits, and experimental data on substance release from consumer products. Default parameter values are set according to the default exposure scenarios. The quality of the collected data is assessed in order to describe whether and where further improvements in consumer exposure estimation with ConsExpo can be achieved, e.g. by collecting more and better data. ConsExpo users are also informed about the uncertainty associated with the data underlying the default parameter values and resulting exposure estimates.

2.1 Default setting

Default parameter values are selected to represent a reasonable worst-case scenario, i.e. one that represents consumers who frequently use a certain product under unfavourable conditions. For example, in the case of cleaning products, parameter values are selected to represent a scenario in which, relative to ‘average’ use, use is frequent and the product is applied in a large amount and in a small room with low ventilation rate, in which the exposed person stays for a long duration.

Although ConsExpo was originally developed for the Dutch consumer market, the parameter values are now aimed at consumers in general. When information is available, and when relevant, differences will be described for the European and North American population.

The parameter values are chosen to generate a reasonable but sufficiently conservative exposure estimate. The reasonable worst-case aims to represent high-end users. To achieve this goal, the 75th or the 25th percentile is determined for each parameter. The 75th percentile is normally used for proportional parameters. However, a decrease in, for example, room volume or ventilation leads to an increase of the exposure estimate. In the case of such reverse proportional parameters, the 25th percentile is used. The dermal, inhalation and oral exposure models included in ConsExpo all require at least three input parameters; most require more. Setting the parameter values to the 75th percentile (or the 25th for parameters that are reversely proportional to exposure) is believed to result in a reasonable and sufficiently conservative estimate for those consumers who frequently use products in large amounts under unfavourable circumstances.

2.2 Quality of the default

The availability of data is different for each exposure parameter. For a number of parameters there are insufficient data to derive a reliable default. To indicate the reliability of a default value, a quality factor (Q-factor) is used. The quality factor ranges from 1 (low quality) to 4 (high quality), see Table 2.1.

Table 2.1 Value of quality factor Q

Q-factor	Description
4	Good-quality relevant data, parameter value reliable
3	Extent and quality of data satisfactory, parameter value usable as default value
2	Parameter value based on single data source supplemented by expert judgement
1	Educated guess, no relevant data available, parameter value based only on expert judgement

Low Q-factors (Q=1 or 2) indicate that the default value is based on data that are not directly compatible with the exposure scenario or data that come from a limited data source and/or are based on expert judgement only. If such defaults are used in an exposure analysis, it should be done with caution, because they are based on expert judgement solely (Q=1) or with limited data (Q=2). If more representative data are supplied by applicants or producers or are available from other sources, these data should be weighted as more accurate than the default value.

High Q-factors (Q=3 or 4), on the other hand, indicate that the defaults are based on sufficient data. High-quality defaults are generally associated with less uncertainty than those with low Q-values. It is possible that some parameters will need to be adapted according to the exposure scenario. For example, if the exposure estimation is carried out on the basis of a room of a size that differs from the default scenario, the actual value should be weighted as more accurate than the default value.

3 About the Air Fresheners Fact Sheet

This is the first version of the Air Fresheners Fact Sheet. The default values were initially selected to represent a European scenario. However, information from other countries, for example the US and Canada, is used as well. ConsExpo is used within different legal frameworks, such as REACH (ECHA, 2016) and the Biocides Regulation (EC, 2012). Special attention is therefore given to default values taken from guidance documents for the implementation of such legal frameworks.

3.1 Air freshener products

Air fresheners or air care products are products that deliver ambient fragrance substances, which serve to mask or remove perceived unpleasant odours or to create a pleasant ambiance due to the presence of perceived nice smells (EC, 2010; Cleanright.eu, 2020). They can take many forms: from scented candles and potpourris to sprays and plug-in devices, with many different fragrances to choose from (Cleanright.eu, 2020). The Air Fresheners Fact Sheet covers the major sources of exposure from the use of air fresheners by consumers. Products that are available on the consumer market to be used to diffuse pleasant scents or to mask unpleasant odours in the home (e.g. living rooms, toilets) or in the car are covered by this Fact Sheet. Products that are meant to be used on items in the house, e.g. on furniture, are included as well as products used as sprays, electric plug-in evaporators, wax melts, scented candles, impregnated solids, odour masks and other products (Table 3.1).

It should be noted that not all fragranced consumer products are considered to be air fresheners. Fragranced consumer products that are intended for personal care, such as perfumes and deodorants, are described in the Cosmetics Fact Sheet (Bremmer et al. 2006a), and fragranced cleaning and laundry products are described in the Cleaning Products Fact Sheet (Meesters et al., 2018). There are, however, products available on the consumer market that serve as both air fresheners and cleaning products, such as toilet rim blocks, furniture sprays, textile sprays, carpet sprays and carpet powders. These products are therefore included in both the Cleaning Products and the Air Fresheners Fact Sheets. They are also included as consumer products in ConsExpo Web under both categories.

Product types that are suitable as both home and toilet air fresheners, such as gel diffusers, potpourri, and capillary reed or wood diffusers, are categorised in this Fact Sheet as ‘home’ air fresheners as opposed to ‘toilet’ air fresheners. Consumer exposure to these products is most considerable when they are used as home air fresheners, because the time spent in a toilet room is limited compared with the time spent in the rest of the home. It is thus anticipated that these products yield higher exposure estimates when they are used as home air fresheners. Toilet sprays and toilet rim blocks, on the other hand, are marketed and developed for specific use in the toilet room only (EC, 2010).

Table 3.1 Air freshener products described in this Fact Sheet

Chapter	Air freshener subcategory	Product formats
6	Home air fresheners	Instant air refreshment sprays Electric plug-in evaporators Automatic puff releasers Sensor puff releasers Scented candles Scented wax blocks Heated oil diffusers Incense sticks Gel diffusers Capillary reed or wood diffusers Nebula diffusers Potpourri
7	Toilet air fresheners	Toilet sprays Toilet rim blocks
8	Car air fresheners	Car interior air sprays Electric evaporators Fragrance-infused items
9	Fabric fresheners	Clothing sprays Interior fabric sprays Scented carpet powders
10	Animal odour masks	Pet urine odour remover sprays Pet urine odour remover foams Pet urine odour remover liquids Pet odour sprays

Car air fresheners and fabric fresheners are also distinct products, because they are not substitutable as home air fresheners. Car air fresheners are generally marketed for specific use inside a car. They are therefore available on the market in appropriate formats, such as fragrance-infused papers that can be hung inside the car, or low-voltage electrical fresheners to plug into the car's electronic device socket and work with the car's ventilation system. Car air freshener products would have little or no functionality in a home, where larger formats are required (EC, 2010).

Fabric fresheners are used to freshen up curtains, carpets or sofas, but are not suitable for eliminating unpleasant odours in the whole home or to create an ambiance, as home air fresheners can.

Animal odour mask products are used to treat objects or surfaces that smell bad because of the presence pets leaving urine stains, hair or dander.

This Fact Sheet principally aims to guide in predicting exposure arising from the use of specific products, independently of the substance of interest. The default values that are presented serve to characterise consumer use of air fresheners. Information about specific substances within the air freshener, such as concentrations and physical-chemical properties, must be considered in the exposure assessment separately by the evaluator. Exposures that are not realistic, such as dermal exposure to gel air fresheners that are in plastic containers, are not considered in this Fact Sheet.

3.2 Ingredients in air fresheners

For air fresheners, disclosure of all ingredients is not required by European legislation, and typically this information is not presented (Steinemann, 2017). The major ingredients of air fresheners can be classified according to their function as a colourant, fragrance, gelling agent, propellant, solvent, surfactant or thickener (Table 3.2).

Table 3.2 Main ingredients of air freshener products from which estimated weight fractions (%w/w) are available (NVZ, 2019)

Ingredient	Air freshener product type		
	Spray (%w/w)	Liquid/gels (%w/w)	Electric evaporators (%w/w)
Colourants	-	<1	<1
Fragrances	0.5–5	1–10	25–100
Preservatives	<1	<1	<1
Solvents	>50	>50	<75
Surfactants	<5	5–50	-

Colourants
Colourants are added to air freshener products for aesthetic reasons or to help the consumer define where the product has been applied or how much product is still in the container (NVZ, 2019; SC Johnson, 2019).

Fragrances
Air fresheners contain perfumes intended to give the consumer a pleasant scent experience. Fragrances are composed of many different materials in 'layers' of scent notes, i.e. top, mid and base notes. The top note delivers a fresh and light scent that is smelled first but evaporates quickly. Mid notes are scents that define the overall body of a fragrance. They emerge as the top note is dissipating. Base notes are heavy and are developed to leave a long-lasting impression. They might not be perceived until 30 minutes after spraying (NVZ, 2019; SC Johnson, 2019).

Gelling agents and thickeners
Gelling agents and thickeners help thicken and stabilise the ingredients to form an air freshener product with a stable and gel-like texture (SC Johnson, 2019).

Preservatives
Preservatives protect the air freshener product formula from bacteria, mould and yeast in order to maintain product quality, human health safety, and performance (NVZ, 2019; SC Johnson, 2019). Preservatives that are biocides fall under the Biocidal Product Regulation (BPR) (ECHA 2015a, 2015b).

Solvents
Solvents dissolve the ingredients of an air freshener product to help them mix together (NVZ, 2019; SC Johnson, 2019).

Propellants
Propellants are compressed in a product container such as a spray can in order to dispense the air freshener product from the container (SC Johnson, 2019).

Surfactants
Surfactants, also referred to as surface-active agents, are organic substances that improve the wetting ability of water and emulsify, solubilise or suspend dirt (ACI, 2015). Surfactants are common ingredients in cleaning products (Meesters et al., 2018) and are also used in air freshener products to treat soiled surfaces or objects with a bad smell.

4 Generic scenarios and models for air fresheners

The use of air freshener products predominantly results in inhalation exposure to substances, but dermal and oral exposure can be expected as well. The exposure is determined by the type of product and the way the product is used. Because product formulation and use are often similar across different air freshener products, exposure scenarios are often quite comparable. Hence, the same models and scenarios can be applied to consumer exposure assessment for different products.
In this chapter, generic scenarios are explained by describing the use of the product, exposure conditions and appropriate ConsExpo models to calculate exposure during product use.

The types of products, product handling and exposure conditions that are considered generic for air fresheners are:

- Spraying of air freshener products (4.1):
  - inhalation of non-volatile substances in sprayed droplets;
  - inhalation of volatile substances released upon spraying;
  - dermal deposition of sprayed droplets;
  - oral ingestion of non-respirable materials.
- Continuous release events (4.2).
- Time-limited release events (4.3):
  - inhalation of evaporated substances.
- Dermal contact upon refills (4.4).
- Exposed population groups (4.5):
  - adult users;
  - infant bystanders;
  - secondary exposed crawling children.
- Exposure locations:
  - home;
  - car;
  - toilet room.

The current chapter addresses scenarios and generic default parameters that are applicable to several products within this Fact Sheet. Chapters 6 to 10 provide the default scenarios, models and parameter values to estimate consumer exposure via the relevant exposure routes for the specific product categories mentioned in Table 3. Detailed descriptions of the models are included in the help files, which are available as web pages in the tab menu of ConsExpo Web as well as in the user manual of ConsExpo Web (Delmaar & Schuur, 2017).

4.1 Spraying of air freshener products

This Fact Sheet describes two types of air freshener sprays:

i. Instant air refreshment sprays – sprayed into the air to immediately mask or treat unpleasant odours in the indoor air or to sprayed into air to create an ambience perceived as pleasant.
ii. Odour cover sprays – sprayed onto a surface or object to mask or treat unpleasant odours evaporating from it.

Three types of spray applications are considered:

i. Pressurised aerosol spray cans that release droplets and volatile substance as long as the spray nozzle is pressed down by the consumer.
ii. Unpressurised pump sprays that release droplets and volatile substances each time the consumer depresses the spray nozzle.
iii. Unpressurised trigger sprays that release droplets and volatile substances each time the consumer pulls a trigger.

The release of substances from the spray applications occurs during the few seconds the consumer is actually spraying, but the duration of inhalation exposure lasts as long as the consumer is in the room. The consumer inhales non-volatile substances in sprayed droplets small enough to reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017), and ingests droplets too large to pass the nasal region. Volatile substances are assumed to be available for inhalation exposure, because they evaporate from the sprayed droplets. Dermal exposure is expected from droplets depositing on the unprotected skin of the hands and arms of the consumer.

4.1.1 *Inhalation of non-volatile substances in sprayed droplets*

The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances in spray droplets. The ‘spraying towards person’ option is not considered relevant here, because instant air fresheners are directed towards the air and cover sprays are directed towards an object or surface.

Spray duration

In general, spray duration is defined here as the net spraying time between the start and finish of spraying, not counting the time between spray puffs (Delmaar & Schuur, 2017; RIVM, 2018).

Spray duration of instant air refreshment sprays

The consumer sprays an instant air refreshment spray by continuously pushing the spray nozzle to release the droplets into the indoor air. The Emissions, Exposure Patterns and Health Effects of Consumer Products (EPHECT) survey (2012) reports that 41% of all users (N=1011) spray for 1 or 2 s, 43% for 3 or 4 s and 17% for 5 s or longer. Thus, the 75th percentile is in the range of 3 to 4 s. Data collected by NIER that is presented by Kim et al. (2018) include a 75th percentile for the spray duration of the Korean population of 3 s for spraying in indoor locations and in cars. The number of respondents in the specific NIER datasets from which the 75th percentile is derived is, however, not publicly available. Therefore, the generic default for spray duration is set to 4 s based on the EPHECT (2012) survey report. However, the dataset of EPHECT refers to a spray event of home air fresheners. The Q-factor is therefore set to 4 for exposure scenarios that specifically refer to the use of instant air refreshment sprays used in the home, because the underlying dataset of EPHECT is large (N=1011) and is supported by the data of NIER (Kim et al., 2018). In case the dataset is used for a scenario with a location other than home, the Q-factor is lowered to 3.

Spray duration of odour cover sprays
Odour cover sprays are used to spray onto objects or surfaces with a bad smell. The amount of product required depends on the type of smell, the object and/or the surface, so that no generic spray duration could be established. The spray duration (s) is therefore calculated per type of cover spray by dividing the sprayed amount (g) by the mass generation rate of the spray (g/s).

Exposure duration
The spraying of an instant air refreshment spray or an odour cover spray is considered to be a time-limited release event, as substances are released only while the consumer is actually spraying. The exposure duration refers to the time the consumer spends in the room during and after the release event, which is, by expert judgement, set at 4 hours with a Q-factor of 1 (see Section 4.3).

Room height
The default room height is based on a standard room height of 2.5 m, as explained in the General Fact Sheet (Te Biesebeek et al., 2014). The Q-factor is set to 4 in accordance with the General Fact Sheet.

Mass generation rate, airborne fraction and aerosol diameter for different spray types and uses
The mass generation rate of a spray product is defined as the mass released per unit time of spraying. Data on mass generation rate is collected per (i) spray type (aerosol spray can, trigger spray or pump spray) and (ii) intended use (instant air refreshment spray or odour cover spray) (Table 4.1). Since the mass generation rate, airborne fraction and aerosol diameter of sprays are correlated (Delmaar & Bremmer, 2009), it is preferred that the default values for these parameters be obtained from the same series of experiments or information source. Where the default values are not collected from the same source, the Q-factors are set to a maximum of 2. The recent NIER data from South Korea presented by Kim et al. (2018) is therefore considered less suitable for the derivation of default mass generation rates, as they do not describe aerosol diameters and airborne fractions of the 20 trigger sprays and aerosol spray cans included in their series of experiments. The Q-factors assigned to the mass generation rates presented by Kim et al. (2018) are therefore set to 1. Additional data published in 2020 by Kim et al. (2020) does include mass generation rates of specific air freshener sprays and therefore their data are selected for the derivation of defaults for specific products described in the product chapters of this Fact Sheet (see Chapters 6–10).

Table 4.1 Overview of mass generation rate, airborne fraction and aerosol diameter of instant air refreshment sprays and odour cover sprays available as aerosol spray can, pump spray or trigger spray

Intended use of spray	Spray type	Mass generation rate	Airborne fraction[1]			Aerosol diameter		Refe renc e(s)
			By use[1]	Scaling factor[1]	Scaled[1]	Median	CV	
Instant air re-freshment	Aerosol spray can	2.0 g/s	1	0.8	0.8	3.9 µm	0.65	Tuinman 2004; Delmaar & Bremmer, 2009
	Trigger spray	0.6 g/s	1	0.09	0.09	2.0 µm	0.39	Tuinman, 2004; Delmaar & Bremmer, 2009; Kim et al., 2020
Odour cover	Aerosol spray can	0.5 g/s	0.2	1	0.2	76 µm	1.76	Tuinman, 2004; Delmaar & Bremmer, 2009
	Pump spray	0.34 g/s	0.2	0.1	0.02	2.7 µm	0.73	Delmaar & Bremmer, 2009; Kim et al., 2020
	Trigger spray	1.7g/s	0.2	0.09	0.018	2.0 µm	0.39	Tuinman, 2004; Delmaar & Bremmer, 2009; Kim et al., 2020

1: Note, the airborne fraction 'by use' refers to the mass fraction of the sprayed droplets that is airborne due to the intended use of the spray. The scaling factor refers to the mass fraction of sprayed droplets <22.5 µm. The scaled airborne fraction is the product of the airborne fraction by use and the scaling factor. The scaled airborne fraction is inserted in ConsExpo Web in the input field for 'airborne fraction'.

4.1.1.1 Aerosol spray cans used for instant air refreshment: mass generation rate, airborne fraction and aerosol diameter

Mass generation rate

Tuinman (2004, 2007) performed a series of experiments to determine mass generation rates, airborne fractions and aerosol diameters of spray droplets released by aerosol spray cans. The mass generation was experimentally determined by pressing the spray nozzle for 10 s and determining the weight loss of the spray can afterwards. To establish the variation in mass generation rate during the lifetime of the product, the weight loss was measured when the spray container was still full and also when the container was nearly empty (Tuinman 2004, 2007). One toilet spray and two home air freshener sprays were included as spray products in these series of experiments. Their mass generation rates were derived as 0.8 g/s, 2.0 g/s and 1.0 g/s, respectively. The generic default mass generation rate for instant air refreshment aerosol spray cans is based on the highest value from the limited number of three samples and thus is 2.0 g/s. The Q-factor is set to 2, because it is derived on a generic level and based on only three different product samples.

Airborne fraction
Instant air refreshment spraying is a form of air space spraying, because the consumer sprays the product into indoor air (Delmaar & Bremmer, 2009). Delmaar & Bremmer (2009) state that spray droplet sizes fitted from experimental data to lognormal distributions over the entire range proved in general to be poor. As the smaller particles in the distribution are the most critical with respect to inhalation exposure, Delmaar & Bremmer (2009) chose to fit the size distributions in the region of diameters up to 22.5 μm, realising that the fit of the distribution for larger particle sizes may not be valid.
In the fit, Delmaar & Bremmer (2009) define an airborne fraction for air space spraying products to be 1 where scaling for small spray droplets is not required. However, the fraction of sprayed droplets <22.5 μm is about 0.8 for instant air refreshment sprays (Tuinman 2004, 2007; Delmaar & Bremmer, 2009), so that a scaling factor of 0.8 is required. The default airborne fraction of instant air refreshment sprays in an aerosol spray can is therefore not set to 1, but scaled to 0.8. The Q-factor is set to 2, because the scaling factor of 0.8 is generic and derived from only three product samples (Tuinman 2004, 2007; Delmaar & Bremmer, 2009).

Aerosol diameter
Delmaar & Bremmer (2009) describe a default median diameter of 3.9 μm with a coefficient of variation (CV) of 0.65 μm for aerosol spray cans used for instant air refreshment that was derived from data from the experiments of Tuinman (2004, 2007). The default agrees quite well with the aerosol diameters characterised by Dua et al. (1995), who measured mass median diameters from four samples of air freshener sprays ranging between 2.6 μm and 3.3 μm, with CVs (calculated from the given geometric standard deviations) ranging from 0.78 to 1.0 μm. The Q-factor is set to 2, because the default is derived from only three product samples described in Delmaar & Bremmer (2009).

4.1.1.2 Trigger sprays used for instant air refreshment: mass generation rate, airborne fraction and aerosol diameter

Mass generation rate
Kim et al. (2020) determined the mass generation rate and aerosol diameter of spray droplets <10 μm released from a trigger spray for the purpose of instant air refreshment. An amount of 3.0 g was sprayed in approximately 5 s; thus the mass generation of the trigger spray is calculated as 0.6 g/s. The data presented in Delmaar & Bremmer (2009) include a generic mass generation of 1.6 g/s for trigger sprays based on 12 samples. However, their data do not include samples of a trigger spray used for instant air refreshment, nor a trigger spray directed towards air space at all. The default generic mass generation rate for trigger sprays used for instant air refreshment is therefore set to 0.6 g/s based on the data of Kim et al. (2020), but the Q-factor is set to 1, because their study includes only one product sample and

complementary data on the airborne fraction and the full size spectrum of sprayed droplets are not available. Moreover, the time component was an approximate value rather than a measured value.

Airborne fraction
When the spray nozzle is directed into indoor air, all sprayed droplets are considered to be airborne (Tuinman, 2004, 2007; Delmaar & Bremmer, 2009; Kim et al., 2020). The generic default mass generation rate (see above) for instant air refreshment trigger sprays is based on Kim et al. (2020), but their study does not include a quantification of the airborne fraction and the aerosol diameter is only characterised for droplets up to 10 µm. Therefore, the default airborne fraction and aerosol diameter (see below) could not be based on the data of Kim et al. (2020). However, there is no other available data source that refers to aerosol diameters and (scaling factors for) airborne fractions of trigger sprays used for air spaces as described in Delmaar & Bremmer (2009). In addition, the airborne fraction of the spray products needs to be scaled to account for the fraction of sprayed droplets that are <22.5 µm. Therefore, it is evaluated what type of trigger spray product would yield the highest inhaled doses in order to derive a conservative default airborne fraction and aerosol diameter. As such, ConsExpo Web simulations have been performed for trigger spray products from which both scaling factors and aerosol diameters are available, which are a ready-to-use spray, an all-purpose cleaner spray, a bathroom cleaner spray and a fine plant spray (Delmaar & Bremmer, 2009). The simulation results demonstrate that the droplets of a fine plant spray are most effectively inhaled compared with the other evaluated spray products. The scaling factor of the plant spray (0.09) is therefore multiplied by the airborne fraction for air space spraying (1) to arrive at a default airborne fraction for instant air refreshment trigger sprays of 0.09. The Q-factor is set to 1, because the underlying product sample is not an instant air refreshment trigger spray.

Aerosol diameter
There is no data source available that includes the full size spectrum of aerosol diameters of the sprayed droplets from trigger sprays used for the purpose of instant air refreshment. Kim et al. (2020) measured the particle number concentrations of air freshener trigger spray directed towards indoor air only up to 10 µm. Therefore, a mass median diameter, an input required by ConsExpo Web, could not be determined from the data of Kim et al. (2020). The default mass aerosol diameter is consequently taken to be that of fine plant spray, because that is the trigger spray in which the combination of aerosol diameter and scaling factor yields the most effective inhalation of droplets (see Airborne fraction above). The median diameter is thus set to 2.0 µm with a CV of 0.39 (Delmaar & Bremmer, 2009; RIVM, 2010). The Q-factor is set to 1, because the underlying product sample is not an instant air refreshment trigger spray.

4.1.1.3 Aerosol spray cans used for odour cover: mass generation rate, airborne fraction and aerosol diameter

Mass generation rate

Tuinman (2004) experimentally determined the mass generation rate of an aerosol spray can used to cover odours evaporating from the surface of an object. The one product sample was a textile air freshener spray, for which a mass generation of 0.5 g/s was derived with the same approach as described for instant air refreshment sprays (Delmaar & Bremmer, 2009). The mass generation rate to generically represent odour cover aerosol spray cans is therefore set to 0.5 g/s. The Q-factor is set to 1, because it the default was derived at a generic level and is based on only one product sample.

Airborne fraction

The spray activity of odour cover sprays resembles that of general surface or object spraying, for which a default airborne fraction of 0.2 is set for aerosol spray cans (Delmaar & Bremmer, 2009; RIVM, 2010). This airborne fraction does not need to be scaled to account for the mass fraction of particles of <22.5 μm (see Aerosol diameter below). Therefore, the airborne fraction for odour cover sprays available in aerosol spray cans is set to 0.2. The Q-factor is set to 2, because it refers to the generic activity of spraying towards the surface of an object with an aerosol spray can.

Aerosol diameter

The aerosol diameter of odour cover aerosol spray cans is derived from the measurements on a textile freshener spray performed by Tuinman (2004). The data of Tuinman (2004) are presented in Delmaar & Bremmer (2009). The cumulative density function of a lognormal distribution is fitted to the size distribution data from Tuinman (2004). A lognormal distribution with a median diameter of 76 μm and a CV of 1.76 appears to be the best fit for the size range of <22.5 μm. In the measurement data of Tuinman (2004), 16% of the volume sprayed consists of droplets <22.5 μm. In the fitted lognormal distribution, the mass fraction of droplets <22.5 μm is 16% as well. Therefore, it is not necessary to scale the airborne fraction to the fitted lognormal distribution. The Q-factor is set to 1, because the value was derived at a generic level and based on only one product sample.

4.1.1.4 Pump sprays used for odour cover: mass generation rate, airborne fraction and aerosol diameter

Mass generation rate

Kim et al. (2020) determined the mass generation rate and aerosol diameter of spray droplets released from a pump spray used for the purpose of odour covering. An amount of 1.7 g was sprayed in approximately 5 s, so that the mass generation rate of the pump spray is calculated as 0.34 g/s. The mass generation rate to generically represent odour cover pump sprays is therefore set to 0.34 g/s. The Q-factor is set to 1, because the default value was derived at a generic level and based on only one product sample. Moreover, the time component was an approximate value rather than a measured value.

Airborne fraction

The spray activity of odour cover sprays resembles that of general surface or object spraying, for which a default airborne fraction of 0.2 is set for pump sprays (Delmaar & Bremmer, 2009; RIVM, 2010). However, the default airborne fraction of odour cover pumps sprays is not set to 0.2, because it needs to be scaled to account for the fraction of sprayed droplets that are <22.5 μm. The default aerosol diameter is taken to be that of an eau de toilette spray due to a lack of specific data (see below). The scaling for eau de toilette spray is 0.1, so that the airborne fraction is scaled to 0.02. The Q-factor is set to 1, because the underlying product sample is not an odour cover pump spray.

Aerosol diameter
There are no data available that include the full size spectrum of aerosol diameters of the sprayed droplets from pump sprays used for the purpose of odour cover. An eau de toilette spray is selected as the product most comparable to an odour cover pump spray, because both are pump sprays, both have the function to eliminate bad odours and both consist mainly of water. The default mass aerosol diameter is therefore taken to be that of an eau de toilette spray (Delmaar & Bremmer, 2009; RIVM, 2010). The median diameter is therefore set to 2.7 μm with a CV of 0.73. The Q-factor is set to 1, because the underlying product sample is not an odour cover pump spray.

4.1.1.5 Trigger spray used for odour cover: mass generation rate, airborne fraction and aerosol diameter

Mass generation rate
Kim et al. (2020) determined the mass generation rate and aerosol diameter of spray droplets released from a trigger spray used for the purpose of odour covering. An amount of 8.5 g was sprayed in approximately 5 s, so that the mass generation of the trigger spray is calculated as 1.7 g/s. The mass generation rate to generically represent odour cover trigger sprays is therefore set to 1.7 g/s. The Q-factor is set to 1, because the default value was derived at a generic level and based on only one product sample. Moreover, the time component was an approximate value rather than a measured value.

Airborne fraction
The spray activity of odour cover sprays resembles that of general surface or object spraying, for which a default airborne fraction of 0.2 is set for trigger sprays (Delmaar & Bremmer, 2009; RIVM, 2010). However, the default airborne fraction of odour cover trigger sprays is not set to 0.2, because it needs to be scaled to account for the fraction of sprayed droplets <22.5 μm. The default aerosol diameter is taken to be that of a fine plant spray due to a lack of specific data (see below). The scaling factor for this product is 0.09 (Delmaar & Bremmer, 2009), so that the airborne fraction is scaled to 0.018. The Q-factor is set to 1, because the underlying product sample is not an odour cover trigger spray.

Aerosol diameter
There are no data available that include the full size spectrum of aerosol diameters of the sprayed droplets from trigger sprays used for the purpose of odour cover. The default aerosol diameter is therefore taken to be that of a fine plant spray, for which the combination of aerosol diameter and scaling factor for the airborne fraction yields the most effective inhalation of droplets (see Section 4.1.1.2). The Q-factor is set to 1, because the underlying product sample is not an odour cover trigger spray.

Density non-volatile
An inventory of non-volatile ingredients (vapour pressure <0.1 Pa) found in instant refreshment aerosol spray cans and odour mask trigger sprays is presented in the table below (Table 4.2). The inventory is based on ingredient information (SC Johnson, 2020) retrieved from websites of the air freshener spray brands that are most used according to the EPHECT survey (EPHECT, 2012).

Table 4.2 Examples of non-volatile ingredients in instant refreshment aerosol spray cans and odour mask trigger sprays (SC Johnson, 2020)

Spray product	**Non-volatile ingredient**	**Function**	**Density[1] (g/cm^3) ECHA, 2021**
Instant air refreshment aerosol spray cans	Disodium phosphate	Corrosion inhibitor	1.68
	Potassium phosphate	Corrosion inhibitor	2.34
	Sorbitan oleate	Emulsifier	1.10
	Steartrimonium chloride	Stabiliser / emulsifier	**0.96**
Odour cover trigger sprays	Cyclodextrin	Odour trapper	1.46
	Silica	Fabric penetrator	2.65
	Dialkyl sodium sulfosuccinate	pH neutralizer	1.67–1.76
	Benzisothiazolinone	Preservative	1.37
	Polyamine polymers	Odour trapper	**1.13**–1.41
Odour cover aerosol spray cans	Cyclodextrin	Odour trapper	1.46
	Dialkyl sodium sulfosuccinate	Disperser	**1.1**
	Sodium citrate	pH balancer	1.7
	Benzisothiazolinone	Preservative	1.37

1: Note, selected default densities are shown in bold type.

Inhalation exposure increases with decreasing density of non-volatile substances. The defaults for *density non-volatile* therefore refer to the non-volatile spray product ingredients with the lowest densities (marked in bold in Table 4.2). These are 0.96 g/cm^3 for instant air refreshment aerosol spray cans, 1.13 g/cm^3 for odour mask trigger sprays and 1.1 g/cm^3 odour mask aerosol spray cans. Furthermore, it is assumed that pump sprays have a comparable ingredient composition to trigger sprays. It is therefore assumed that the *density non-volatile* for odour cover trigger sprays also applies to pump sprays. The Q-factor is set to 1, because the number of data samples is limited.

Inhalation cut-off diameter
The *inhalation cut-off diameter* is defined as the diameter below which the sprayed particles can be inhaled and reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017). The deposition of particles in the lung is complicated process to simulate, so that a generic inhalation cut-off diameter needs to approximated. Delmaar & Schuur (2017) approximated a generic *inhalation cut-off diameter* in the range of 10-15 µm. In order to be conservative, the default for the inhalation cut-off diameter is set here at 15 µm. The Q-factor is considered to be 3, because the value the derivation of Delmaar & Schuur (2017) specifically refers to inhalation cut-off diameter. However their motivation is qualitative.

4.1.2 *Inhalation of volatile substances released upon spraying*
The inhalation exposure to volatile substances in air freshener sprays is estimated using the ***inhalation–exposure to spray–instantaneous release model***.

Released mass
Released mass is interpreted here as the product amount that is sprayed out of the bottle, can or pump. Therefore, the defaults for released mass (g) are calculated by multiplying the mass generation rate (g/s) by the spray duration (s), which are already described in section 4.1.1 as the defaults for estimating inhalation exposure to non-volatile substances from spraying air fresheners. The Q-factor that is to be assigned for released mass is equal to the lowest Q-factor assigned to the respective mass generation rate or spray duration.

4.1.3 *Dermal deposition of sprayed droplets*
During a spray event, sprayed droplets deposit from the spray cloud onto unprotected skin of the consumer. The ***dermal–direct product contact–constant rate model*** is used to calculate such dermal exposure resulting from spray applications that are directed into the air or towards objects or surfaces. The selected model requires only contact rate and release duration as input parameters that are not specific to an ingredient or substance. The default contact rate values for aerosol spray cans, pump sprays and trigger sprays are explained below and summarised in Table 4.3. The release duration, however, depends on the use of the specific product and therefore no default is given below. Instead, the generic approach used to derive default release durations is explained below.

Exposed area
Exposed area is interpreted here as the surface area of unprotected skin on which (most of) the sprayed aerosols deposit, which are the hands and forearms of an adult. Comparable values are found in different literature sources:

- In the General Fact Sheet (Te Biesebeek et al., 2014) default values (25th percentiles on Dutch data) for the surface area of the hands (900 cm^2) and forearms (half surface area arms: 1300 cm^2) of adults are described.

- In the recommendation of the Ad Hoc Working Group on Human Exposure to Biocides (HEAdhoc, 2017), default values for the surface area of the hands (820 cm^2) and forearms (1320 cm^2) are calculated from defaults given in the US-EPA Handbook (US-EPA, 2011).

Here, the default value for the exposed area is set at 2200 cm^2 in agreement with the General Fact Sheet. The Q-factor is set to 3, because the value is supported by quantitative data that do not refer to the specific use of air freshener sprays. Here it should be noted that the *contact rate* (see below) includes all body parts on which the spray product may deposit, so that the dermal dose will be estimated conservatively. The default *exposed area*, however, is reduced to the hands and forearms only (which are the skin areas on which the droplets mainly deposit) so that the dermal load will be estimated conservatively as well.

Contact rate
The contact rate here refers to the rate at which a spray product deposits onto the skin of a consumer present in the spray cloud. The contact rate depends on the type of spray as well as the direction it is sprayed in (ECHA, 2015a). Instant air refreshment sprays are generally sprayed in an overhead direction, whereas odour mask sprays are directed towards a surface or object. There are therefore five different contact rates, which are described below.

Contact rate – aerosol spray cans used for instant air refreshment
The dermal deposition while using instant refreshment aerosol spray cans is considered similar to that of non-professional space spraying with an aerosol can (ECHA, 2015a). Therefore, the contact rate for hands and forearms is 156 mg/min and the contact rate for legs, face and feet is 113 mg/min, yielding a total contact rate of 269 mg/min. Thus, the default contact rate for instant air refreshment aerosol spray cans is rounded to 270 mg/min. The Q-factor is 3 because the underlying dataset is large but does not refer to a specific exposure scenario.

Contact rate – pump sprays used for instant air refreshment
There are data available on hand-held pump sprays used for space spraying (HSL, 2001), from which a 75th percentile contact rate of 98.4 mg/min is modelled for hands and forearms and 22.7 mg/min for legs, feet and face (ECHA, 2015a). Therefore, a rounded constant rate of 120 mg/min for air space spraying of pump sprays can be derived. The Q-factor is 3 because the underlying dataset is large but does not refer to a specific exposure scenario.

Contact rate – trigger sprays used for instant air refreshment
The dermal deposition while using instant refreshment trigger sprays is considered to be similar to that of non-professional space spraying with a hand-held trigger spray (ECHA, 2015a). Therefore, the contact rate on hands and forearms is 136 mg/min and for legs, face and feet 42.4 mg/min, yielding a total contact rate of 178 mg/min. The default contact rate for instant air refreshment trigger sprays is therefore rounded to

180 mg/min. The Q-factor is 3 because the underlying dataset is large but does not refer to a specific exposure scenario.

Contact rate – aerosol spray cans used to cover odours from surfaces
ECHA (2015a) provides data for consumer spray products available as pressurised aerosol spray cans that suitable as input data for exposure models for consumer spray products and dusting models developed by HSL in 2001. This non-professional surface spraying model for indoor surfaces describes the use of pre-pressurised aerosol spray cans, e.g. for skirting, shelves and horizontal/vertical laminate surfaces. The model calculates a 75th percentile of 64.7 mg/min for dermal exposure on hands and forearms and a 75th percentile of 35.7 mg/min for legs/feet and face, so that the total contact rate for the use of aerosol spray cans is 100 mg/min. Hence, the default for *contact rate aerosol spray cans* is set at 100 mg/min. The Q-factor is 2, because the underlying dataset is large but does not refer to a specific exposure scenario and it is a conservative decision to assume that deposition is on hands, arms, legs and feet.

Contact rate – pump sprays used to cover odours from surfaces
There is no data source available that describes the contact rate of hand-held pump sprays used to treat a general surface. There are, however, data available on hand-held pump sprays used for space spraying (HSL, 2001), from which a 75th percentile contact rate of 98.4 mg/min is modelled for hands and forearms and 22.7 mg/min for legs, feet and face (ECHA, 2015a). Therefore, a default of 121 mg/min for air space spraying of pump sprays can be derived. Modelled contact rates for air space spraying (ECHA 2015a, HSL 2001) are, however, higher than those for general surface spraying, e.g. a factor of 2.7 for aerosol spray cans (calculated as 270 mg/min and 100 mg/min) and a factor of 3.9 for trigger sprays (calculated as 180 mg/min and 46 mg/min). Therefore, it is estimated that the contact rate for pump sprays used to treat a general surface is about a factor of 3 lower than for air space spraying. The default contact rate for treating general surfaces with a pump spray is therefore set to 40 mg/min. The Q-factor is set to 1, because there are no experimental data available that underpin this default.

Contact rate – trigger sprays used to cover odours from surfaces
For the use of a hand-held trigger spray, ECHA (2015a) describes a non-professional surface spraying model for spraying indoors in small rooms, e.g. sofas, dining chairs and carpets. The 75th percentile in the contact rate data for dermal exposure on hands and forearms is 36.1 mg/min and for legs/feet and face the 75th percentile is 9.7 mg/min, yielding a total contact rate of 45.8 mg/min. Hence, the default contact rate for odour mask trigger sprays is set at 46 mg/min. The Q-factor is 3 because the underlying dataset is large but does not refer to a specific exposure scenario.

Table 4.3 Overview of dermal contact rates for aerosol spray cans, pump sprays and trigger sprays used to cover odours from surfaces or instant air refreshment

Spray product	Contact rate (mg/min)	Q-factor	Reference
Instant air refreshment			
Aerosol spray cans	270	3	ECHA, 2015a
Pump sprays	120	3	HSL, 2001; ECHA, 2015a
Trigger spray	180	3	ECHA, 2015a
Surface odour cover			
Aerosol spray cans	100	2	HSL, 2001; ECHA, 2015a
Pump sprays	40	1	Calculated from HSL, 2001; ECHA, 2015a (see above)
Trigger sprays	46	3	ECHA, 2015a

Release duration
Dermal exposure during a spraying activity is anticipated from sprayed product amounts that deposit onto the skin of the consumer. The duration over which substances can deposit is calculated to include both the actual spraying events and the time between spraying events. The default release duration is therefore not equal to the net spray duration described in the scenarios for inhalation of spray products. Instead it is assumed that the release duration is equal to the intermitted spray duration, which is estimated as twice the net spray duration (Prud'homme de Lodder et al., 2006a).

4.1.4 *Oral ingestion of non-respirable materials*

Non-respirable oral exposure is expected from materials in aerosol particles with a diameter larger than the inhalation cut-off. Particles of this size are deposited in the higher regions of the respiratory tract, so that they are taken up orally. ConsExpo offers the option to 'include oral non-respirable material exposure'. If this option is checked, ConsExpo adds an oral route model to the exposure scenario and accounts for the non-respirable fraction of the inhaled spray. The generic approach here is to include oral exposure to non-respirable materials in scenarios where the spray is directed into the room air (air space spraying). For sprays directed towards surfaces this option is not recommended and therefore not included by default because the larger particles are most likely to deposit on the surface to which the spray is directed (although it can be included as a precaution).

4.2 Continuous release events

Continuous release events are defined in this Fact Sheet as scenarios in which a substance is being released to the indoor air, so that a steady state air concentration is achieved in due time. Continuous release only stops once the product is exhausted and thus continues even if the consumer leaves the room. Examples of air freshener products continuously releasing substances are passive evaporators such as impregnated solids, liquids or gels, as volatile substances evaporate from the product matrix into the indoor air. There are also a few examples of active evaporators, such as electric evaporators, that remain plugged in even if the consumer is not present in the room (EPHECT, 2012). Such

continuous release eventually leads to a steady state concentration of substances in the indoor air.
The air concentration (mg/m^3) is calculated in ConsExpo (Web) as the amount of substance in the air (mg) divided by the room volume (m^3), i.e. $C=m/V$. The amount of substance in the air (m) is at steady state once the amount of substance that is removed by ventilation per unit of time (g/h) is equal to the amount emitted per unit of time (g/h) from the product. Thus, the amount of substance in the air at steady state (m in g) equals the emission rate (e in g per hour) of the substance divided by the ventilation rate constant (q in number of air exchanges per hour), i.e. $m=e/q$ (Mackay, 2001). A steady state is, however, not achieved instantaneously. Air concentrations first increase over time until the removal of the substance is equal to the emission of the substance, at which point the steady state is reached and the air concentrations remain constant over time. The time required to achieve a steady state depends on the effectivity of the removal by ventilation of the room and can be approximated for different room types (see Table 4.4).

Table 4.4 Time required to reach steady state indoor air concentrations per default ventilation rates per room type

Room type	Default ventilation rate[1]	Time required to reach steady state air concentration[2]
Living room	0.5 per hour	11 hours
Unspecified room	0.6 per hour	11 hours
Toilet	2 per hour	3 hours
Bathroom	2 per hour	3 hours
Bedroom	1 per hour	6 hours
Kitchen	2.5 per hour	2 hours
Shed	1.5 per hour	4 hours
Garage	1.5 per hour	4 hours

1 (Te Biesebeek et al., 2014)
2. ConsExpo Web simulations have been performed to derive these timescales. Based on the numeric output of ConsExpo Web, the time at which dynamic air concentrations approximate steady state air concentrations is calculated.

Air freshener products are considered to be continuous release sources if substances are being continuously released over a prolonged period of time released, so that a steady state is achieved. The application of air freshener products with high release frequencies can lead to (semi-) steady state air concentrations. Automatic puff releasers, for example, emit a puff every half an hour which is a too short time span for the ventilation to effectively remove released substances, so that air concentrations build up nonetheless. Product information on passive and permanently plugged-in active evaporators claims that it may take weeks or months before the product is exhausted. Consequently, the air concentration pattern over time consists of an increase over a period of a few hours to reach steady state (Table 4.4) followed by a period in which the air concentration remains constant for weeks or months. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released from continuous evaporators. This model is preferred over other models available in ConsExpo (Web) that are more complex, e.g. the *inhalation–exposure to vapour–evaporation model* or the *inhalation–emission from solids model*, because there are insufficient data available to calculate (default) values for the input fields of these models.

Frequency
Frequency refers to the number of times per year that the product needs to be replaced due to exhaustion. The time required for the product to be exhausted varies and is usually described in product information (see below). Therefore, the frequency (assuming that the product is replaced directly after exhaustion) needs to be estimated from product information.

Exposure duration
The exposure duration is set equal to the emission duration, which refers to the time it takes for the product to be exhausted (see below). In other words, in continuous release events the exposure duration refers to the period during which the air freshener product is active.

Product amount
The product amount refers to the amount of air freshener product that is released into the indoor air.

Emission duration
The emission duration refers to how long it takes for the product to be exhausted. Therefore, the emission duration is derived from product-specific information.

4.3 Time-limited release events

Air freshener products such as air freshener sprays, scented candles, wax melts, heated oil diffusers, incense sticks, nebula diffusers and vacuum cleaner additives do not continuously emit substances. They depend on a mechanically or heat driven force to actively release substances into the indoor air. For example, a scented candle releases (most) fragrance substances while burning, whereas a vacuum cleaner additive releases fragrance substances by the mechanically driven air flow of the vacuum cleaner. Emission stops when the force is withdrawn by the consumer, e.g. the scented candle is blown out or the vacuum cleaner is switched off. Thus, the emission duration of substances from these air freshener applications is limited by the period in which the underlying release force is active. Nonetheless, inhalation exposure may continue after the emission is ended, as the consumer may stay in the room. The ***inhalation–exposure to vapour–constant rate model*** is therefore used to estimate inhalation exposure to substances evaporating from non-continuous evaporators.

Exposure duration
The exposure duration refers to the time the consumer spends in the room during and after the release event. However, data referring to the time the consumer remains in the room after release are often not available. The exposure duration is therefore based on the average time consumers spend on leisure activities for which they remain in the same room of the home. This refers mostly to the time spent using media, which, according to the Social Cultural Planning Bureau (SCP), is at most 4 hours a day (SCP, 2019). The generic exposure duration for time-

limited release events is therefore set to 4 hours. This period includes both the time during which the emission source is active and the time the consumer spends in the room after the emission stops. The Q-factor is set to 1, because it is unclear to what extent the activity described as 'media use' actually represents the time spent in a room in which a time-limited release event has occurred due to the use of an air freshener product.

Product amount
The product amount refers to the amount of product that is depleted during the release event. It is derived by multiplying the time during which the mechanical or heat force is active (in hours) by the rate at which the product is depleted (g/h). For example, the rate at which a scented candle burns or a wax block melts is multiplied by the duration the candle is burning or the wax block is melting.

Emission duration
The emission duration refers to the time during which the mechanical or heat-driven force that causes emissions of the air freshener product is active.

4.4 Dermal contact upon refills

Air fresheners that emit liquids into the indoor air need refilling once the product is exhausted. Dermal exposure is expected when a liquid product needs to be poured from a bottle or refill flask into the reservoir (<100 ml) of an air freshener container, electric evaporator or puff releaser. The consumer may spill the liquid air freshener product onto the hand holding the reservoir of the device. This activity is comparable to the pouring of liquid cleaning products into small vessels such as caps or small flasks. The Cleaning Products Fact Sheet describes ConsExpo (Web)'s ***dermal–direct product contact–instant application model*** to estimate dermal exposure in such cases, with defaults for the parameters *exposed area* and *product amount* (Meesters et al., 2018).

Exposed area
The default exposed area is set to 53 cm^2. It is derived from the skin area of the limb parts holding the flask, which are the thumb and the top two phalanges of the forefinger and middle finger. Half of this skin area is pressed to the flask, so that the other half is available for any spills (Meesters et al., 2018). The Q-factor of the default of 53 cm^2 is set to 2, as the estimation for the exposed area is based on several assumptions, even though the default for hand surface area is derived from a rich data source.

Product amount
The default product amount for dermal exposure for pouring liquids into small vessels (such as the reservoirs of air freshener devices) is calculated as the exposed area (53 cm^2) multiplied by the layer thickness (0.01 cm) and density (1 g/cm^3): 0.53 g.
The layer thickness applied is taken from the Guidance on the EU Biocidal Products Regulation (BPR) (ECHA, 2015b), in which a general layer thickness for liquid runoffs is set at 0.01 cm. This value is supported by scientific literature. The US-EPA (2011) conducted a study

with 74 measurements of layer thickness (each as a mean of 4 samples per volunteer), which showed that only one value was (slightly) higher than 0.01 cm (0.01187 cm). Weerdesteijn et al. (1999) performed an experiment involving the immersion of hands into a bucket of water and calculated, based on the surface area of male and female hands, a 75^{th} percentile layer thickness of 0.009 and 0.007 cm, respectively. Based on ECHA (2015b), US-EPA (2011) and Weerdesteijn et al. (1999), it is assumed that a layer thickness of 0.01 cm is appropriate for calculating the product amount in the case of dermal exposure from loading liquids into small flasks. Therefore, the default product amount is set at 0.53 g with a Q-factor of 3, because it is supported by quantitative but generic (non-specific) data.

4.5 Exposed population groups

Three population groups are described in the exposure assessment for consumers: users, bystanders (here described as persons that are exposed only from being present in the same room in which the air freshener is applied), and secondary exposed persons (here described as persons who are exposed as a result of a second activity after application).

4.5.1 *Adult users*

The user refers to the person applying the product, so a consumer who actively enables air freshener products to work, e.g. lights a scented candle, handles a spray can or activates an electric evaporator. The user is considered to be an adult. As both men and women use air freshener products, the default values for body weight, surface areas of body parts and inhalation rates of users refer to adults in general. The defaults for these anthropometric parameters are taken from the defaults given in the General Fact Sheet (Te Biesebeek et al., 2014).

Body weight – adult users
The default body weight is set to 68.8 kg with a Q-factor of 4 (Te Biesebeek et al., 2014).

Inhalation rate – adult users
It is considered that the exposed individuals are ‘at rest’ during inhalation exposure events that do not involve physical exertion. The default inhalation rate is therefore set to 0.55 m^3/h (9.2 l/min). If the consumer needs to perform a task that includes some physical exertion, e.g. vacuum cleaning, the default inhalation rate is set to 1.49 m^3/h (25 l/min), which is the inhalation rate for ‘light exercise’. The Q-factor is set to 3, since the defaults do not refer to measured inhalation rates, but to an inhalation rate calculated using the body weight of the consumer (Te Biesebeek et al., 2014).

4.5.2 *Infant bystanders*

Substances released by air freshener products disperse through the indoor air of the room, reaching product users and bystanders that are also present in the room. These bystanders can be of any age, but inhalation exposure doses are highest for individuals with a high inhalation rate relative to body weight. Infants (aged 1–3 months) are therefore most intensely exposed via the inhalation route compared with other age groups. The age group of 1–3 months is therefore selected to represent the population group of bystanders.

Body weight – infant bystanders
As explained above, bystanders are represented by the age group 1–3 months. The default body weight of this group is taken from the General Fact Sheet (Te Biesebeek et al., 2014) and set to 4.5 kg with a Q-factor of 4.

Inhalation rate – infant bystanders
Infant bystanders are considered to be at rest during the inhalation exposure scenarios. The default inhalation rate is taken from the General Fact Sheet (Te Biesebeek et al., 2014) and set to 0.1 m^3/h (1.7 l/min) with a Q-factor of 4.

4.5.3 *Secondary exposed crawling children*
The secondary exposed group refers in this Fact Sheet to infants crawling over a surface that has been treated with an air freshener product, e.g. scented carpet powder. The exposure calculations in these specific scenarios are based on a 6–12-month-old child (the age at which children crawl). The default body weight for this age group is set to 8 kg, as explained in the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

4.6 Exposure locations
The exposure scenarios describe consumer exposure to air fresheners in the home (living spaces and toilets) and in cars, although air freshener products may also be used in other settings, such as public toilets, shops, schools and offices.

4.6.1 *Home*
The intended use of home air freshener products is not limited to a specific room in the home. Thus, the consumer may choose to place air freshener units in any room of the home (EPHECT, 2012). The exposure location of home air freshener products is therefore characterised by the parameter defaults that refer to an unspecified room, as described in the General Fact Sheet (Te Biesebeek et al., 2014).

Frequency
The frequency refers to the number of times per year the consumer is present in the room in which the air freshener is active. By default the frequency is set to 365 per year to reflect a daily pattern of time spent in the same room of the home. The Q-factor is set to 1, because the default is based solely on expert judgement.

Exposure duration
The exposure duration refers to the number of hours or minutes the consumer spends in the room in which an active air freshener is present. The default exposure duration due to the presence of the consumer in the same room is set to 4 hours with a Q-factor of 1 (see *Exposure duration* in Section 4.3).

Room volume
The default room volume is set to 20 m^3 with a Q-factor of 4 as it refers to an unspecified room as described in the General Fact Sheet (Te Biesebeek et al., 2014).

Room height
The General Fact Sheet (Te Biesebeek et al., 2014) describes a default room height of 2.5 m with a Q-factor of 4, as it refers to the standard room height of housing in The Netherlands.

Ventilation rate
The default ventilation rate constant is set to 0.6 per hour with a Q-factor of 3, as it refers to an unspecified room as described in the General Fact Sheet (Te Biesebeek et al., 2014).

4.6.2 *Car*
For air freshener products used in cars, the exposure location refers to a relatively small car with poor ventilation, as these are the conditions in which inhalation exposure is expected to be highest. The A-segment represents the smallest class of cars on the road (Danish EPA, 2017b; US-EPA, 2020). In addition, measurements performed by Ott et al. (2008) indicate that ventilation rates are lower in A-segment cars compared with cars in other segments. Therefore, the default exposure location for car air freshener products is an A-segment car.

Exposure duration
The exposure duration refers to the time spent by the consumer in the car. Mobility data from the Netherlands indicate that frequent car travellers spend on average an hour per day inside a car (CBS, 2020). Therefore, the default exposure duration for car interior air fresheners is set to 1 hour. The Q-factor is set to 2, because the default is based on an average.

Room volume
A-segment cars have a typical volume of 2.4 m^3 (Danish EPA, 2017b; USEPA, 2020). The default room volume for air freshener products intended to be used in cars is therefore set to 2.4 m^3. The Q-factor is set to 3, because it is a standard volume for a recognised segment of cars.

Room height
The room height refers to the height of the interior of an A-segment car, which is typically 1.5 m (USEPA, 2020). The Q-factor is set to 3, because it is a standard height for a recognised segment of cars.

Ventilation rate
Measurements performed by Ott et al. (2008) indicate that ventilation is poorer in A-segment cars than in the other car segments. The lowest ventilation rate (1.5–2.8 air exchanges per hour) was measured at low driving speed (30 km/h; 20 mph) with the windows closed and the ventilation system turned off (Ott et al., 2008). The default ventilation rate is therefore set to 1.5 per hour, which reflects the lowest ventilation rate in these measurements. The Q-factor is set to 3, because the underlying data specifically refer to the ventilation rates of cars under

realistically unfavourable conditions, but the number of measurements (N=6) is small.

4.6.3 *Toilet room*

The location of exposure scenarios for air freshener products intended to be used in toilets is characterised by the default parameter values that refer to a toilet room as described in the General Fact Sheet (Te Biesebeek et al., 2014).

Frequency
The default frequency for toilet air fresheners is based on the number of toilet visits per day. Ten toilet visits per day is considered to be normal behaviour (Heaton et al., 1992; B&B Community, 2017). The default frequency is therefore set to 10 per day. The Q-factor for this default is set to 2, because the supporting data are limited.

Exposure duration
The exposure duration refers to the time the consumer spends per toilet visit. According to the Cleaning Products Fact Sheet, it is normal to spend 5 minutes on a toilet visit (Meesters et al., 2018). The default exposure duration is therefore set to 5 min. The Q-factor for this default is set to 2, because the supporting data are limited.

Room height
The General Fact Sheet (Te Biesebeek et al., 2014) describes a default room height of 2.5 m with a Q-factor of 4, as this refers to the standard room height of housings in The Netherlands.

Room volume
The default room volume of a toilet room is 2.5 m^3, in accordance with the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Ventilation rate
The default ventilation rate is set to 2 per hour with a Q-factor of 3 in accordance with the General Fact Sheet (Te Biesebeek et al., 2014).

5 Information

5.1 EPHECT survey

The EPHECT project (Emissions, Exposure Patterns and Health Effects of Consumer Products in the EU) is a collaborative project, co-funded by the European Union, in which important information has been gathered about the use of cleaning products by European consumers (EPHECT, 2012). The report on the EPHECT survey was published in 2012 (EPHECT, 2012) and additions are published in 2015 (Dimitroulopoulou et al., 2015a, 2015b; Trantallidi et al., 2015). The survey was designed to collect household use data for 16 consumer products across 4 geographical regions of Europe. A total of 4,335 people from 10 European countries (Czech Republic, Germany, Denmark, Spain, France, Hungary, Italy, Poland, the UK and Sweden) were interviewed.

Four of the 16 products considered were air fresheners and a large number of survey respondents stated that they used such products, namely combustible air fresheners (N=1004), air freshener sprays (N=1364), electric air fresheners (N=952) and passive air fresheners (N=822).

The EPHECT (2012) survey results suggest that European consumers tend to follow the user instructions of air freshener products, as stated by 60% of the respondents using combustible air fresheners (N=1004), by 53% of those using air freshener sprays (N=1364) and by 72% of those using electric air fresheners (N=952).

For this reason, product use instructions are consulted here in cases where representative data are not available for ConsExpo (Web) input parameter fields such as product amount, use frequency or applications. The Q-factors are nevertheless generally set to 2, because a considerable fraction of survey respondents stated that they did not respect the user instructions and, even in cases where they claimed to do so, actual use did not necessarily correspond to user instructions.

5.2 NIER Survey

The South Korean National Institute of Environmental Research (NIER) conducted a nationwide survey study to compile a database for calculating exposure factors of consumer products (Lee et al., 2018; Kim et al., 2020). Some of these exposure factors are used in ConsExpo (Web) as input fields, e.g. product amounts, application durations and use frequencies. The survey includes data on air freshener products used in indoor locations and vehicles as sprays, liquids, candles or gels (Kim et al., 2020), but the actual number of respondents from which the percentiles were derived to characterise the consumer use of these specific products is not available (Kim et al., 2018; Lee et al., 2018). The total number of respondents to the NIER survey was 10,000 (Park et al., 2019), but it is not clear how many of these respondents provided information on the consumer use of air fresheners in specific. The NIER data are referred to in this Fact Sheet to describe to what extent other data sources may agree with the NIER data. Q-factors are therefore not assigned to the NIER data.

6 Home air fresheners

In this Fact Sheet, 'home air fresheners' refers to air freshener products that release a substance into room air to create a smell or ambiance in the home. Their intended use is inside the home, but not in a specific room or location. Home air fresheners can thus be used in multiple rooms of the home. The home air fresheners included in this Fact Sheet are instant air refreshment sprays, electric plug-in evaporators, automatic puff releasers, sensor puff releasers, scented candles, scented wax blocks, heated oil diffusers, incense sticks, gel diffusers, capillary reed or wood diffusers, nebula diffusers, potpourri and vacuum cleaner fragrance additives.

6.1 Instant air refreshment sprays

Scenarios for consumer exposure
Instant air refreshment sprays are available on the market as aerosol spray cans and trigger sprays. The consumer is exposed to the air freshener spray ingredient substances dermally, orally and via inhalation. Due to spraying, the consumer will inhale either volatile substances that evaporate upon release or non-volatile substances in sprayed droplets small enough to reach the alveolar region (Delmaar & Schuur, 2017). Substances in droplets too large to reach the alveolar region, but small enough to be inhaled, are considered to be orally ingested.
The respondents to the EPHECT survey (EPHECT, 2012) stated that they used instant air refreshment sprays in different rooms of the home, such as the living/dining room (42%), kitchen (28%), bedroom (26%), hallway (25%), closet/storage room (9%) and other rooms (6%). The location in which instant air freshener sprays are used is thus not limited to a specific room in the home. Therefore, the exposure location is characterised by the default parameter values that refer to an unspecified room (see Section 4.6.1), as described in the General Fact Sheet (Te Biesebeek et al., 2014).
The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in home air refreshment sprays, whereas the ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances. The default *mass generation rate, airborne fraction, density non-volatile* and *aerosol diameter* are based on the generic scenario for spraying instant air refreshment sprays (see Section 4.1.1). Furthermore, the use of instant air refreshment sprays is considered to be an air space spraying activity, so that the option to 'include oral ingestion of non-respirable material' is selected (4.1.4). The exposure duration is based on the generic scenario for time-limited release events (4.3). Dermal exposure is expected from droplets containing substances depositing from the spray cloud onto the unprotected skin of the hands and arms of the consumer. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of the dermal exposure from such deposition of sprayed droplets (4.1.3).

Frequency
Ter Burg et al. (2014) performed exposure estimations for ingredients in air fresheners for which a use frequency of 5 times per day for air freshener sprays was considered worst-case. The frequency as described in Ter Burg et al. (2014) is taken from earlier exposure estimations by Park et al. (2006), who describe the use frequency of air freshener sprays to be 1 to 5 times per day based on expert judgement. This figure is in agreement with the results of the EPHECT (2012) survey, as the respondents representing the 75th percentile (N=1364) used a home instant refreshment spray 'at least once a day', which is the highest frequency included in the multiple-choice answers of the EPHECT (2012) survey. The survey data collected by Holzwarth et al. (2017) among German consumers of air freshener products indicate that about 15% of the users of air freshener sprays use them several times per day and 23% once per day. Hence, the 75th percentile for the use frequency of air freshener spray product is 'once per day' according to Holzwarth et al. (2017). Lee et al. (2018) derived a 75th percentile use frequency of once per day from the NIER (2016) data for inhabitants of Korea. The default frequency for using instant air fresheners is therefore set to 365 per year to reflect 'once a day', because this frequency agrees with the EPHECT data, the NIER data and the data of Holzwarth (2017). The Q-factor is set to 4, because the underlying datasets are large and agree well with each other.

Spray duration
The default spray duration for home instant air refreshment sprays is set to 4 s based on the survey data from EPHECT (2012). The NIER survey data present a 75th percentile of 4 s for sprays to deodorise indoor air. The Q-factor is set to 4 given the large number of respondents in the underlying EPHECT dataset (N=1364) that refer to the use of home air refreshment sprays and agree very well each other.

Exposure duration
The spraying of instant air refreshment sprays is considered to be a time-limited release event, so that the exposure duration refers to a generic exposure duration of 4 hours with a Q-factor of 1 (see Section 4.3).

Mass generation rate
The default mass generation rates for home air freshener sprays refer to the mass generation rates generically derived for non-volatile substances in instant air refreshment sprays available as an aerosol spray can or trigger spray, which are 2.0 g/s and 0.6 g/s, respectively (see Section 4.1.1).

Airborne fraction
The default airborne fractions refer to the airborne fractions generically derived for non-volatile substances in instant air refreshment sprays available as aerosol spray cans or trigger sprays, which are 0.8 and 0.03 with Q-factors 2 and 1, respectively (see Section 4.1.1).

Density non-volatile
The density of non-volatile substances is taken from the generic scenario of spraying instant air refreshment sprays (see Section 4.1.1).

Thus, the default for instant air refreshment aerosol spray cans is set to 0.96 g/cm^3 with a Q-factor of 2 (4.1.1). There were no data available for trigger sprays. Therefore, the default density of non-volatile substances for instant refreshment trigger sprays is set to 0.96 g/cm^3, which equates to the lowest density of all non-volatile ingredients in air freshener sprays (Table 4.2 in Section 4.1.1). The Q-factor for trigger sprays is set to 1, because the default does not refer to a trigger spray used for instant air refreshment.

Aerosol diameter
The default aerosol diameters for home air freshener sprays refer to the aerosol diameters generically derived for instant air refreshment sprays available as aerosol spray cans or trigger sprays. These are characterised by a lognormal distribution with a median diameter of 3.9 μm and a CV of 0.65 for aerosol spray cans and a median diameter of 2.0 μm and a CV of 0.39 for trigger sprays (see Section 4.1.1).

Released mass
The released mass is calculated by multiplying the mass generation rate by the spray duration. The released mass is thus 8.0 g for aerosol spray cans and 2.4 g for trigger sprays. The Q-factors are set to 2 and 1, respectively, as they are derived from the Q-factors of the mass generation rates.

Table 6.1 Default values for estimating consumer exposure to substances in home air freshener sprays

Default value		Q-factor	Source(s)
General			
Frequency	365 per year	4	See this section
Inhalation–exposure to spray–spraying model			
Spray duration[1]	4 s	4	EPHECT, 2012; NIER, 2016
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	20 m^3	4	Section 4.6.1
Room height[1]	2.5 m	4	Section 4.6.1
Ventilation rate[2]	0.6 per hour		Section 4.6.1
Inhalation rate[1]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	2.0 g/s	2	Section 4.1.1.1
- *trigger spray*	0.6 g/s	1	Section 4.1.1.2
Airborne fraction[1]			See this section
- *aerosol spray can*	0.8	2	Section 4.1.1.1
- *trigger spray*	0.09	1	Section 4.1.1.2
Density non-volatile[1]			
- *aerosol spray can*	0.96 g/cm^3	1	Section 4.1.1.1
- *trigger spray*	0.96 g/cm^3	1	See this section
Inhalation cut-off diameter[1]	15 µm	3	Section 4.1.1
Aerosol diameter median (CV)[1]			
- *aerosol spray can*	3.9 µm (0.65)	2	Section 4.1.1.1
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.2
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate (Section 4.1.2)
- *aerosol spray can*	8.0 g	2	
- *trigger spray*	2.4 g	1	
Dermal–direct product contact–constant rate[1]			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray can*	270 mg/min	3	Section 4.1.3
- *trigger spray*	180 mg/min	3	Section 4.1.3
Release duration	8 s	3	Twice the spray duration (Section 4.1.3)

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

6.2 Electric plug-in evaporators

Scenario for consumer exposure

Electric plug-in evaporators are considered to be 'electric air fresheners'. The respondent data from the EPHECT (2012) survey on the consumer use of electric air fresheners is therefore considered to be relevant to the consumer exposure scenario for electric plug-in evaporators. The EPHECT (2012) survey indicates that 37% of consumers leave an electric air freshener device permanently plugged in and that 40% of consumers use the device on a daily basis and 30% use it 'at any time/ no specific moment' of the day.

The use of electric plug-in evaporators is considered to be a continuous release event (see Section 4.2). Consequently, the frequency, exposure duration and emission duration depend on each other. The frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration.
The EPHECT survey respondents stated that they might use electric air fresheners in any room of the home, including the bedroom. An electric air freshener is thus used throughout the home and not limited to a specific room. The location of the exposure scenario is therefore considered to be an unspecified room (see Section 4.6.1).
Dermal exposure can be expected during refilling events, in which the consumer pours the liquid air freshener product from a refill flask into the container of the evaporator device. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to the substances released, whereas the ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure while filling the reservoir of the electric evaporator device (4.4). Inhalation exposure during refilling events is considered to be negligible compared with inhalation exposure from evaporation from the device. Furthermore, it is implicitly assumed that the consumer uninterruptedly stays in the room in which the air freshener is placed for weeks or months, but in reality a consumer enters, remains in and leaves a room within a pattern of daily life activities. Therefore, the exposure scenario can be refined by including a duration of stay parameter (see Annex I).

6.2.1 *Electric evaporation*

Frequency
The default emission duration is set to 60 days, because the liquid fragrance product in electric evaporators is exhausted after this period (see Emission duration). Consequently, the reservoir of the device needs to be refilled 6 times per year, which is chosen as the default frequency. The Q-factor is set to 2, because the underlying data are based on product information.

Exposure duration
The exposure duration is set equal to the emission duration as they are both interpreted as the number of days in which the device is active. The default exposure duration is thus set to 60 days with a Q-factor of 2.

Product amount – inhalation
Product emission data indicate that a total of 38.6 g of liquid air freshener product is released over an emission duration of 1440 hours (60 days) (Jansen et al., 2018; 2019; Visschedijk et al., 2020). The default product amount is rounded to 39 g. The Q-factor is set to 2, because the underlying data are based on product information.

Emission duration
Product emission data indicate that the liquid fragrance product in electric evaporators is exhausted after a mean period of 1440 hours (i.e. 60 days) (Jansen et al., 2018; 2019; Visschedijk et al., 2020). The default emission duration is thus set to 60 days. The Q-factor is set to 2, because the underlying data are based on product information.

Table 6.2 Default values for estimating consumer exposure to substances released by electric evaporators

Default value		Q-factor	Source(s)
General			
Frequency[1]	6 per year	2	Jansen et al., 2018, 2019; Visschedijk et al., 2020
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	60 days	2	See this section
Product amount	39 g	2	Jansen et al., 2018, 2019; Visschedijk et al., 2020
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	60 days	2	See this section
Dermal–direct product contact–instant application			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

1: Use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. In case the user chooses to deviate from one of these defaults, the other defaults need to be corrected for consistency.

6.2.2 *Refilling*

The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure during refilling.

Frequency

The default frequency for dermal exposure from refilling is set to 6 per year because the estimated service life of an electric plug-in evaporator refill is 60 days (see Frequency in Section 6.2.1). The Q-factor is set to 2, because the underlying data are based on product information.

Table 6.3 Default values for estimating consumer exposure via skin to substances in electric evaporators during refill events

Default value		Q-factor	Source(s)
General			
Frequency	6 per year	2	Section 6.2.1
Dermal–direct product contact–instant application model			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

6.3 Automatic puff releasers

Scenario for consumer exposure

Automatic puff releasers are devices that release an amount of fragrance into indoor air about every half an hour (glade.com, 2020). An automatic puff releaser is also referred to as an 'electric air freshener' in the EPHECT study. Therefore, the respondent data of the EPHECT (2012) survey on the consumer use of electric air fresheners is considered to be relevant to this product category. The consumer use pattern indicates that, like plug-in evaporators (Section 6.2), electric air

fresheners can be active for 24 hours per day in multiple rooms. The frequency and emission/exposure durations for plug-in evaporators are therefore considered suitable for automatic puff releasers as well.
Due to the programmed release interval of automatic puff releasers, normal home ventilation is not able to effectively remove all released substance between two release events. The default ventilation rates in the General Fact Sheet range from 0.5 to 2.5 indoor air exchanges per hour (Te Biesebeek et al., 2014), whereas a puff is released every half an hour. It is therefore calculated that, dependent on the type of room, the ventilation reduces 20–70% of the substances between each puff release. This is calculated as *(100% × exp(-ventilation rate × time);* with 0.5-2.5 ventilation per hour over a time period of 0.5 hours. Consequentially, air concentrations will accumulate over time until the amount of substance that is removed during the half-hour interval is equal to the amount that is released in the next puff. The release of substances from automatic puff sprays is therefore considered to be semi-continuous, which means in this scenario that the release of substances is continuous enough to employ a constant rate model. In this model, the air concentration does not increase once a steady state is reached, so that the steady state concentration is also the peak concentration. Since the use of automatic puff releasers is not limited to a specific room in the home, the defaults for room volume and ventilation rate refer to those of an unspecified room (see Section 4.6.1).
The ***inhalation–exposure to vapour–constant release model*** is used to estimate the expected inhalation exposure of the consumer residing in the room where the device is located (4.2). Note that the dispersion of non-volatile substances throughout the room is oversimplified with the selected model because the model does not include deposition to indoor surfaces by gravitational settling as a removal process. However, more suitable models to accurately simulate the dispersion of (semi-) continuously released non-volatile substances are not available in ConsExpo (Web). Dermal exposure can be expected during refilling events, when the consumer pours the air freshener product from a refill flask or bottle into a small reservoir on the puff releaser device. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure (4.4). Inhalation exposure during refilling events is considered to be negligible compared with the inhalation exposure from the released puffs (see below).

6.3.1 *Inhalation from released puffs*

Frequency

Use frequency, exposure duration and emission duration depend on each other in this consumer exposure scenario. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. Product information indicates that an automatic puff releaser refill is exhausted after 60 days if the standard settings of one puff per half an hour are used (glade.com, 2020). The EPHECT (2012) survey indicates that consumers may leave the device active for 24 hours per day, with the air freshener product exhausted after 60 days. A refill is then needed 6 times per year. The default frequency of the semi-continuous release events of puffs is therefore set to 6 per year. The Q-factor is set to 2, because the underlying data are based on product information.

Exposure duration
The exposure duration is set equal to the emission duration as they are both interpreted as the number of days in which the device is active. The default exposure duration is thus set to 60 days with a Q-factor of 2 (see Emission duration).

Product amount
Product information indicates that 175 g of air freshener product is exhausted after 60 days of puff releases if the device is set to the standard setting of one puff per half an hour (glade.com, 2020). The default product amount is thus set to 175 g. The Q-factor is set to 2, because the underlying data are based on product information.

Emission duration
The default emission duration is 60 days, which refers to the number of days an automatic puff releaser refill lasts. The Q-factor is 2, because the default exposure duration is based on the same data as the default frequency (see above).

Table 6.4 Default values for estimating consumer exposure to substances released by automatic puff releasers

Default value		**Q-factor**	**Source(s)**
General			
Frequency[1]	6 per year	2	Product information (see above)
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	60 days	2	Equal to emission duration (see above)
Product amount	175 g	2	Product information (see above)
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- adult users	0.55 m^3/h	3	Section 4.5.1
- infant bystanders	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	60 days	2	Product information (see above)

1: Use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. In case the user wants to deviate from one of these defaults, the other defaults need to be corrected for consistency.

6.3.2 *Refilling*
The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure during refilling.

Frequency
The default frequency for dermal exposure from refilling is set to 6 per year because the estimated life span of an automatic puff release refill is 60 days (see Frequency in Section 6.3.1). The Q-factor is set to 2, because the underlying data are based on product information.

Table 6.5 Default values for estimating consumer exposure via skin to substances in automatic puff releasers during refill events

Default value		**Q-factor**	**Source(s)**
General			
Frequency	6 per year	2	Section 6.3.1
Dermal–direct product contact–instant application model			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

6.4 Sensor puff releasers

Scenarios for consumer exposure

Sensor puff releasers release fragrances into the air each time a sensor detects the movement of a person in the room. Under normal circumstances, the sensor would detect such movement approximately 340 times in a products service life of 30 days (glade.com, 2020). Fragrance release and inhalation exposure are limited to the time during which the consumer is in the room, because no movement is detected in the absence of a person in the room. This is in contrast to electric evaporators (Section 6.2) and automatic puff releasers (6.3), which emit substance 24 hours a day irrespective of whether anyone is in the room. The activity of sensor puff releasers is therefore interpreted as a time-limited release event. The number of puff releases per unit of time is, however, still high enough to consider the emission to be semi-continuous, which means in this scenario that the release of substances is continuous enough to employ a constant rate model. Therefore, the ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released from sensor puff releasers. Note that the dispersion of non-volatile substances throughout the room is oversimplified with the selected model, because the model does not include deposition to indoor surfaces by gravitational settling as a removal process. However, more suitable models to accurately simulate the dispersion of (semi-)continuously released non-volatile substance are not available in ConsExpo (Web).

Furthermore, the intended use of sensor puff releasers is not limited to a specific room in the home. The location in which inhalation exposure takes places is therefore considered to be an unspecified room (see Section 4.6.1).

The consumer is expected to refill the container of the sensor puff releaser once the product is exhausted. Dermal exposure can be expected during refilling events, when the consumer must pour liquid air freshener product from a refill flask or bottle into the reservoir of the puff release device. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure during refilling events (Section 4.4). Inhalation exposure during refilling events is considered to be negligible compared with the inhalation exposure from released puffs (see below).

6.4.1 *Inhalation from released puffs*

Frequency

The frequency is set to 365 times per year, which reflects the use of sensor puff releasers on a daily basis. This is in line with the EPHECT (2012) data, which indicate that daily use of electric air fresheners is common practice. The Q-factor is set to 3, because the underlying data do not refer to sensor puff releasers specifically, but to electric air fresheners in general.

Exposure duration
The default exposure duration for room presence is set to 4 hours with a Q-factor of 1, because the activity of sensor puff sprays is interpreted as a time-limited release event (see Section 4.3).

Product amount
The product amount refers to the amount of product that is released into the indoor air per day. One puff unit holds about 12 g of liquid, which is exhausted after 340 puffs. Each puff thus consists of 35 mg. Under normal circumstances, the sensor would detect 340 movements in 30 days (glade.com, 2020), which equals on average 11.3 puffs per day. Movement is detected only if the consumer is present in the room. A continuous presence of 4 hours per day in the same unspecified room is characterised as normal circumstances (see *Exposure duration* above and Section 4.3.). It is therefore assumed that all puffs released in a day are during the 4 hours in which the consumer is present the room. Consumers would thus be detected on average 11.3 times during the 4-hour exposure duration, so that they are exposed to about 400 mg of product (11.3 × 35 mg ≈ 400 mg). The default product amount is thus set to 400 mg as a rounded conservative estimate. The Q-factor is set to 1, because the default is based on product information and expert judgement.

Emission duration
The emission duration is set equal to the exposure duration, which is 4 hours with a Q-factor of 1.

Table 6.6 Default values for estimating consumer exposure by inhalation to substances released by sensor puff releasers

Default value		**Q-factor**	**Source(s)**
General			
Frequency	365 per year	3	EPHECT, 2012
Inhalation–exposure to vapour–constant rate model			
Exposure duration	4 hours	1	SCP, 2019
Product amount	400 mg	1	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	4 hours	1	See above

6.4.2 *Refilling*
The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure during refilling.
Frequency
The default frequency for dermal exposure from refilling is set to 12 per year because the estimated life span of a puff releaser unit is 30 days (SC Johnson, 2020). The Q-factor is set to 2, because it is derived from product information.

Table 6.7 Default values for estimating consumer exposure via skin to substances in sensor puff releasers during refill events

Default value		Q-factor	Source(s)
General			
Frequency	12 per year	2	See this section
Dermal–direct product contact–instant application model			
Exposed area Product amount	53 cm^2 0.53 g	2 3	Section 4.4 Section 4.4

6.5 Scented candles

Scenarios for consumer exposure

Scented candles actively release substances into the room when they are lit. The results of the EPHECT survey (2012) indicate that consumers light two candles several times a week and leave them burning for 1 to 2 hours. The use of scented candles is not limited to a particular room in the home but they are most often used in the living room (81%). A large group of consumers also use scented candles in another room, i.e. the bedroom (31%), bathroom (26%), kitchen (24%) and other rooms (EPHECT, 2012). The scenario of inhalation exposure from lighting scented candles is therefore interpreted to take place in an unspecified room (see Section 4.6.1). It is assumed that the consumer does not leave the room while the candles are burning and stays in the room after the candles are extinguished. Burning scented candles is thus considered to be a time-limited release event (4.3). Inhalation exposure to substances that passively evaporate from unlit candles is possible (Uhde & Schulz, 2015) but will be less than the inhalation exposure from actively burning candles for 1 to 2 hours several times a week. Passive evaporation is therefore not included as an exposure scenario. Exposure estimation of (hazardous) substances formed from incomplete combustion is also outside the applicability domain of ConsExpo (Web) and therefore not included here as an exposure scenario.

The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released by burning scented candles. Dermal exposure is also expected, as the fingers of the consumer touch the scented candles when placing them in the room. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure from handling candle wax.

6.5.1 *Inhalation from burning scented candles*

Frequency

About 19% of the European consumers that use combustible air fresheners, such as scented candles, do so on a daily basis, whereas 31% do so 'several times a week' (EPHECT, 2012). The German survey report of Holzwart et al. (2017) states that 2% of the German users of scented candles use them 'several times daily', 11% 'once per day' and 19% 'several times per week'. From the data of both EPHECT (2012) and Holzwarth et al. (2017) it is derived that the respondents representing the 75th percentile light candles 'several times a week'. The default frequency is thus set to 6 times per week by interpolating the survey data of EPHECT (2012). The default is rounded to 300 times per year. Regarding the estimation of the Q-factor, the underlying dataset of EPHECT (2012) is large (N=1004), but it refers to the use frequency of combustible air fresheners in general. However, scented candles are the most often used form of combustible air freshener included in this dataset (as 87% of respondents who use combustible air freshener stated they used scented candles). The default derived from combustible air fresheners in general is therefore strongly represented by scented candle use. Thus, the Q-factor is set to 3, as the default frequency is interpolated from data.

Exposure duration
There are no data available on the time the consumer spends in the room after the candles are blown out. The default exposure duration is therefore set to 4 hours, which refers to the time the consumer may uninterruptedly spend on leisure activities in one room (see Section 4.3). The Q-factor is set to 1, because the default exposure duration is based principally on expert judgement.

Product amount
The default product amount refers to the amount of candle wax emitted to the indoor air during the 2 hours' burning time. According to the EPHECT survey (2012), the respondents representing the 75th percentile would burn two scented candles simultaneously. The Korean NIER data presents a 75th percentile for the burning rate of one scented candle of 4.8 g/h (Kim et al., 2018). Danish EPA (2017a) describes candle burning rates of 6.9 g/h, 9.1 g/h and 9.9 g/h for the purpose of measuring specific released substances. Product emission data from the Netherlands describe the weight and exhaustion time of 8 different scented candles. The average burning rate can be calculated by dividing the product amounts by the respective exhaustion times (Jansen et al., 2018; 2019; Visschedijk et al., 2020). The 75th percentile from these calculated burning rates is 3.8 g/h, and the maximum rate is 4.8 g/h. The calculation of the default product amount therefore includes a burning rate of 5 g/h, which captures the data of NIER (Kim et al., 2018), DEPA (2017a) and Visschedijk et al. (2020) and is considered a conservative estimate.
The burning rate of one candle is rounded to 5 g/h based on the data described above. The burning of 2 candles for 2 hours thus leads to a burned amount of candle wax of 20 g (2 × 2 hours × 5 g/h = 20 g). The default product amount is thus set to 20 g. The Q-factor is set to 2, because the default is estimated from different underlying datasets.

Emission duration
The emission duration refers to the time the scented candles are lit. The EPHECT (2012) survey data indicate that the respondents representing the 75th percentile would light candles for 2 hours. This duration is in agreement with the 75th percentile for the emission duration of scented candles described in the NIER (2016) data (Kim et al., 2018). The default emission duration is thus set to 2 hours. The Q-factor is set to 4, because of the size of the underlying EPHECT dataset (N=1004).

Table 6.8 Default values for estimating consumer exposure by inhalation to substances released by burning scented candles

Default value		**Q-factor**	**Source(s)**
General			
Frequency	300 per year	3	EPHECT, 2012
Inhalation–exposure to vapour–constant rate model			
Exposure duration	4 hours	1	See this section
Product amount	20 g	2	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	2 hours	4	Kim et al., 2018; EPHECT, 2012

6.5.2 *Handling candle wax*

Replacing the candles after they are burned out is considered to be an activity that is comparable to handling wax blocks, as described in the European Guidance on Biocidal Products Regulation (BPR). Here, the consumer touches the wax with the fingers (30 cm^2), on which a layer thickness of 0.01 cm of product is left behind (ECHA, 2015a).

Frequency
A normal scented candle is burned out after 27 hours (Jansen et al., 2018; 2019; Visschedijk et al., 2020). According to the EPHECT (2012) survey, the consumer burns two candles for 2 hours per day, indicating that both candles need replacement after 14 days, which is on average one candle per week. The replacement of the old candle stump with a new scented candle is interpreted here as one handling activity. The default frequency is thus set to once a week, i.e. 52 per year. The Q-factor is set to 2, because underlying datasets need to be combined.

Exposed area
The exposed area is set equal to that of handling wax blocks, as described in the BPR guidance (ECHA, 2015a), which is 30 cm^2. The Q-factor is set to 2, because the underlying data relate to biocidal wax blocks and not to scented candles.

Product amount
According to BPR guidance (ECHA, 2015a), a layer thickness of 0.01 cm is left on the human skin. The volume of product on the human skin is therefore 0.01 cm × 30 cm^2 = 0.3 cm^3. The density of candle wax (paraffin) is about 0.93 g/cm^3, resulting in a product amount available for dermal exposure of 0.28 g. The Q-factor is set to 1, because the calculation via layer thickness is a crude estimation.

Table 6.9 Default values for estimating dermal consumer exposure to substances in scented candles from handling candle wax

Default value		Q-factor	Source(s)
General			
Frequency	52 per year	2	See this section
Dermal–direct product contact–instant application model			
Exposed area Product amount	30 cm^2 0.28 g	2 1	ECHA, 2015a See this section

6.6 Scented wax blocks

Scenario for consumer exposure
Scented wax blocks containing fragrance substances are available as combustible air fresheners. The intended use is to place a wax block on a platelet or holder. The consumer lights a small candle or a small electric heating device located just under the platelet, so that the wax is heated until it melts and evaporates. During the heating process, substances are emitted into the indoor air to which inhalation exposure is anticipated. The estimation of exposure to substances formed from incomplete combustion is outside the applicability domain of ConsExpo (Web) and therefore not included here as an exposure scenario. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances emitted by melting fragranced wax blocks. Dermal exposure is expected when the fingers of the consumer touch the scented candles while placing the candles in the room. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure from handling candle wax.

6.6.1 *Inhalation from heating scented wax blocks*

Frequency
The default frequency is set to 300 per year based on the survey data of EPHECT (2012). However, this frequency does not specifically refer to the use of wax melts, but to combustible air fresheners in general. (The survey does not include a question about the use of wax melts.) The Q-factor is therefore set to 2.

Exposure duration
There are no data available on the time a consumer spends in the room after the scented wax blocks are no longer heated. The default exposure duration is therefore set to 4 hours, which refers to the time the consumer may uninterruptedly spend on leisure activities in one room (see Section 4.3). The Q-factor is set to 1, because the default exposure duration is based mainly on expert judgement.

Product amount
The product amount is calculated here by multiplying the emission duration (see below) by the amount of product that is depleted per hour. Product information indicates that 66 g of wax blocks lasts for 110 hours (glade.com, 2020), so that 66 g/110 h x 2 h = 1.2 g is released in an emission duration of 2 hours. The default product amount is thus set to 1.2 g. The Q-factor is set to 2, because it is derived from product information.

Emission duration
The use of a scented wax block is assumed to be similar to that of a scented candle. The emission duration is therefore set to 2 hours (see Section 6.5). The Q-factor is set to 2, because the default does not specifically refer to the emission duration of scented wax blocks but to scented candles, which are considered comparable products.

Table 6.10 Default values for estimating consumer exposure by inhalation to substances released by melting scented wax blocks

Default value		**Q-factor**	**Source(s)**
General			
Frequency	300 per year	2	See this section
Inhalation–exposure to vapour–constant rate model			
Exposure duration	4 hours	1	Section 4.3
Product amount	1.2 g	2	Product information
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	2 hours	2	Section 6.5

6.6.2 *Handling scented wax blocks*
Replacing the scented wax blocks after they are burned out is considered to be an activity comparable to handling wax blocks, as described in the BPR guidance (ECHA, 2015a). Here, the exposed individual touches the wax with the fingers (30 cm^2), on which a layer thickness of 0.01 cm of product is left behind (ECHA, 2015a).

Frequency
Product information indicates that a scented wax block is burned out after 110 hours of burning (SC Johnson, 2020). The consumer is considered to burn the wax block for 2 hours per day, so that the wax block needs to be replaced every 55 days, which is equal to 7 times per year. The frequency is thus set to 7 per year. The Q-factor is set to 1, because underlying data are very limited.

Exposed area
The exposed area is set equal to that for handling wax blocks described in the BPR guidance (ECHA, 2015a), which is 30 cm^2. The Q-factor is set to 2, because the default refers to handling wax and it is unclear to what extent this represents the specific handling of scented wax blocks.

Product amount
According to the BPR guidance (ECHA, 2015a), a layer thickness of 0.01 cm is left on the skin. The volume of product on the skin is therefore 0.01 cm × 30 cm^2 = 0.3 cm^3. The density of scented wax (paraffin) is about 0.93 g/cm^3 (ECHA, 2021), so that the product amount available for dermal exposure is 0.28 g. The Q-factor is set to 1, because the calculation via layer thickness is an expert judgement-based estimation.

Table 6.11 Default values for estimating dermal consumer exposure to substances in wax blocks from handling residues

Default value		**Q-factor**	**Source(s)**
General			
Frequency	7 per year	1	See this section
Dermal–direct product contact–instant application model			
Exposed area Product amount	30 cm^2 0.28 g	2 1	ECHA, 2015a See this section

6.7 Heated oil diffusers

Scenario for consumer exposure
Heated oil diffusers are described here as platelets or holders into which the consumer needs to pour an amount of fragranced oil (neat or onto a small layer of water). The consumer then lights a small candle located just under the platelet, so that the oil is heated and evaporates. The heated oil contains fragrance substances that travel through the room air. The intended use is to pour an amount of fragranced oil onto the platelet or holder, from which dermal exposure is anticipated. During the heating process, substances are emitted into the indoor air, so that inhalation exposure is anticipated. The exposure scenario is considered to be a time-limited release event (see Section 4.3), because the consumer is not expected to leave the room while the candle under the platelet is burning. Exposure estimation of substances formed from incomplete combustion is outside the applicability domain of ConsExpo (Web) and therefore not included here as an exposure scenario. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances emitted by heating the fragranced oil. Dermal exposure is expected while pouring the oil from a bottle or flask onto platelet or holder. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure from spills that may occur during refilling, given the smallness of the vessels (4.4).

6.7.1 *Inhalation of heated oil*

Frequency
The default frequency is set to 300 per year based on the survey data of EPHECT (2012). However, this frequency does not specifically refer to heated oils, but to combustible air fresheners in general. (The use of heated oils is not specifically referred to in this survey.) The Q-factor is therefore set to 2.

Exposure duration
There are no data available on the time the consumer spends in the room after the essential oil is no longer heated. The default exposure duration is therefore set to 4 hours, which refers to the time the consumer may uninterruptedly spend in a room on leisure activities (see Section 4.3). The Q-factor is set to 1, because the default exposure duration is based mainly on expert judgement.

Product amount
The product amount is calculated by multiplying the emission duration (see below) by the amount of product that is depleted per hour. The rate at which the heated oil evaporates from the platelet or holder is assumed to be similar to that of an electric plug-in device (see Section 6.2),

because both types of air freshener product actively evaporate essential oils using an external heat source. Electric plug-in devices evaporate 39 g of essential oil in 60 days (6.2), which is equal to 0.027 g per hour. The product amount evaporated during the 2-hour emission duration is thus calculated to be 2 × 0.027 = 0.054 g = 54 mg. The default product amount is thus set to 54 mg. The Q-factor is set to 1, because it is derived from product information of a product other than a heated oil diffuser.

Emission duration
The use of heated oils is assumed to be similar to that of combustible air fresheners such as scented candles and wax blocks. The emission duration is therefore set to 2 hours (see Sections 6.5 and 6.6). The Q-factor is set to 2, because the default does not specifically refer to the emission duration of heated oils but to scented candles and wax blocks, which are considered comparable products.

Table 6.12 Default values for estimating consumer exposure by inhalation to substances released by heated oil diffusers

Default value		**Q-factor**	**Source(s)**
General			
Frequency	300 per year	2	See this section
Inhalation–exposure to vapour–constant rate model			
Exposure duration	4 hours	1	Section 4.3
Product amount	54 mg	1	Product information
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	2 hours	2	Section 6.5

6.7.2 *Refilling*
Filling the platelet or holder with oil is considered to be an activity that fits the generic exposure scenario of dermal contact during refilling (see Section 4.4).

Frequency
The frequency with which the consumer needs to refill the platelet or holder with fragranced oil depends on how the consumer decides to use the air freshener product. The consumer may decide to refill the platelet or holder before each heating event, either by pouring just enough oil onto the holder for one heating event or by adding oil before each heating event. The consumer may also decide to fully fill the platelet or holder and refill it again when the oil is depleted after a number of heating events. The conservative approach is to assume that the consumer refills the platelet or holder before each heating event, so that the frequency is 300 per year with a Q-factor 2 (see Section 6.7.1).

Table 6.13 Default values for estimating consumer exposure via skin to substances in heat essential oil during refill events

Default value		Q-factor	Source(s)
General			
Frequency	300 per year	2	Section 6.7.1
Dermal–direct product contact–instant application model			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

6.8 Incense sticks

Scenario for consumer exposure
The consumer burns incense sticks to release a smell into the room. During such a burning process, smoke is formed that disperses into the indoor air and hazardous substances can be formed due to incomplete combustion (Jetter et al., 2002). The estimation of exposure to (hazardous) substances formed during combustion is, however, outside the applicability domain of ConsExpo (Web). Therefore, it is recommended to use ConsExpo (Web) only for substances that are present as ingredients that do not burn, e.g. heavy metals (Lin et al., 2007). The dispersing smoke is a mixture of volatile gases and damps and non-volatile soot particles (Jetter et al., 2002). It is assumed that both volatile and non-volatile substances are dispersed via smoke. Inhalation exposure is anticipated as the consumer inhales the smoke formed during the burning process. The burning of incense sticks is interpreted as a time-limited release event, because the consumer is expected to stay in the room during the time the incense sticks are burning plus a duration of time after the sticks have burned out (see Section 4.3). The use of incense sticks is not limited to one particular room in the home. The location of the exposure scenario is thus considered to be an unspecified room (4.6.1). The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released from burning incense sticks.

Frequency
The use of incense sticks is included in the EPHECT (2012) survey dataset (N=1004), and 18% of the respondents that used combustible air fresheners stated that they use incense sticks. The frequency is set to 300 per year, which equates to the frequency for the use of combustible air fresheners in general. The Q-factor is set to 2 because of the assumption that the generic use frequency of combustible air fresheners is applicable to the specific use of incense sticks.

Exposure duration
There are no data available on the time the consumer spends in the room after the incense sticks have been extinguished or burned out. The default exposure duration is therefore set to 4 hours, which refers to the time the consumer may uninterruptedly spend in a room on leisure activities (see Section 4.3). The Q-factor is set to 1, because the default exposure duration is based largely on expert judgement.

Product amount
The product amount here refers to the weight of the incense sticks that are being burned. Jetter et al. (2002) and Lin et al. (2007) characterised

the emission of particulate matter by burning incense. Their data include the sample weights of incense sticks. The 75th percentile in the combined dataset (N=20) is 1.4 g for one incense stick. In a health assessment report by Eggert & Hansen (2004), it is stated that a consumer most often burns one incense stick at a time. The default product amount is thus set to 1.4 g. The Q-factor is set to 2, because the underlying data on the number of sticks burned at a time are limited.

Emission duration
The emission duration here refers to the time an incense stick takes to burn out. The 75th percentile in the combined dataset (N=20) of Jetter et al. (2002) and Lin et al. (2007) is 65 min for one incense stick. The Q-factor is set to 3, because the underlying datasets are consistent with each other and specifically refer to the burning time of an incense stick.

Table 6.14 Default values for estimating consumer exposure to substances from burning incense sticks

Default value		**Q-factor**	**Source(s)**
General			
Frequency	300 per year	2	EPHECT, 2012
Inhalation–exposure to vapour–constant rate model			
Exposure duration	4 hours	1	Section 4.3
Product amount	1.4 g	2	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- adult users	0.55 m^3/h	3	Section 4.5.1
- infant bystanders	0.1 m^3/h	4	Section 4.5.2
Emission duration	65 min	3	Jetter et al., 2002; Lin et al., 2007

6.9 Gel diffusers

Scenario for consumer exposure
Gel diffusers are passive diffusers available on the consumer market as small jars, bottles or plastic holders that contain a jelly component from which fragrances evaporate into indoor air. Evaporation starts after the consumer has prepared the gel diffuser by removing a lid, plastic foil or cover. During such preparation activity dermal contact with the gel product is not anticipated. Upon preparing the gel diffuser it is anticipated that a very brief high release may take place, for a few seconds, but this is considered negligible compared with the continuous inhalation exposure that occurs once the product has been prepared and placed in the room. The EPHECT (2012) survey data indicate that the respondents representing the 75th percentile use two units of gel air fresheners on one occasion. The use of passive air fresheners such as gel diffusers is not limited to one specific room in the house but can take place in multiple rooms of the house including the bedroom (EPHECT, 2012). Therefore, the location of the exposure scenario is an unspecified room (see Section 4.6.1) and the emission is considered to continue until the product is exhausted (4.2). The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances evaporated from gel diffusers.

It is implicitly assumed that the consumer uninterruptedly stays in the room in which the air freshener is placed for weeks or months, but in reality a consumer enters, remains in and leaves a room within a pattern of daily life activities. Thus, the exposure scenario can be refined by including a duration of stay parameter (see Annex I).

Frequency
The frequency of exposure refers to the number of times per year that the gel diffusers are replaced after being exhausted. Product information indicates that a standard gel air freshener unit of 150 g is exhausted after 30 days (SC Johnson, 2020). The default frequency is therefore set to 12 per year. The Q-factor is set to 2, because the underlying data are based on product information only.

Exposure duration
The emission duration refers to the time between the preparation of the gel air freshener and the moment at which the product is exhausted. The exposure duration is thus set equal to the emission duration. The default exposure duration is thus set to 30 days. The Q-factor is set to 2, because the underlying data are based on product information only.

Product amount
The product amount refers to the amount of product that is exhausted after 30 days of continuous emission. Product information indicates that a gel diffuser unit of 150 g is exhausted after 30 days (SC Johnson, 2020). The NIER data (Kim et al., 2018) describes comparable emission amounts, namely that the typical emission rate of a gel type air freshener is 0.20 g/h, which is equal to 150 g in 30 days. The 75th percentile in the NIER data indicates an emission rate of 0.28 g/h per hour, which is about equal to 200 g in 30 days. According to Standardised Consumer Exposure Determinants (SCEDs) provided by AISE (2015), a gel diffuser's exhaustion rate is 2.5 g/day, so that 75 g would be released in 30 days. The EPHECT (2012) data indicate that the consumer may use two units of gel air freshener on one occasion, but it is unclear whether the two units are placed in the same room. The default product amount is set to 200 g based on one gel diffuser unit placed in an unspecified room exhausting 200 g in 30 days (Kim et al., 2018). The Q-factor is set to 3 on the basis that the different datasets agree with each other to some extent.

Emission duration
In the consumer exposure scenario, the default emission duration refers to the time between the preparation of the gel diffuser and the moment at which the product is exhausted. According to product information, a gel air freshener unit is exhausted after 30 days (SC Johnson, 2020). The default emission duration is thus set to 30 days. The Q-factor is set to 2, because the underlying data derive from product information only.

Table 6.15 Default values for estimating consumer exposure to substances released by gel diffusers

Default value		Q-factor	Source(s)
General			
Frequency[1]	12 per year	2	Product information
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	30 days	2	Product information
Product amount	200 g	3	Kim et al., 2018; EPHECT, 2012; product information
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	30 days	2	Product information

1: Use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. In case the user wants to deviate from one of these defaults, the other defaults need to be corrected for consistency.

6.10 Capillary reed or wood diffusers

Scenario for consumer exposure

Capillary reed or wood diffusers are air freshener products that are available as jars holding an essential oil into which porous wooden or reed sticks are placed. The tops of the sticks are in the indoor air, the opposite ends in the jar. The oil is absorbed by the sticks and transported by capillary action. Thus exposed to the room air, volatile liquid substances slowly diffuse at the interface between the indoor air and the outer surface of the sticks (Angulo-Milhem et al., 2020). Product information also describes another way of using capillary diffusers (reeddiffusers.org, 2020). The sticks are dipped in the essential oil at the bottom of the jars and then turned around, so that the liquid oily product is directly at the interface between the room air and the surface of the porous sticks. In this way, the evaporation proceeds more rapidly, because it no longer needs the capillary transport (reeddiffusers.org, 2020).

Inhalation exposure is anticipated as substances evaporate from the surface of the sticks into the room air. Placing capillary reed or wood diffusers in a room is interpreted as a continuous release event, because the release continues in the absence of the consumer (see Section 4.2). Therefore, the ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances evaporated from the capillary reed or wood diffusers. Dermal exposure is expected on the fingertips of the consumer when the sticks are turned around. The ***dermal–direct product contact–instant application model*** is used to estimate this.

It is implicitly assumed that the consumer uninterruptedly stays in the room in which the air freshener is placed for weeks or months, but in reality a consumer enters, remains in and leaves a room within a pattern of daily life activities. Therefore, the exposure scenario can be refined by including a duration of stay parameter (see Annex I).

Frequency
The use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. The product use frequency refers in this scenario to how often the consumer needs to turn the sticks for the evaporation of fragrance substances to remain effective. This is about once a week according to product information (reeddiffusers.org, 2020). The default frequency is therefore set to 52 per year. The Q-factor is set to 2, because the default is derived from product information only.

Exposure duration
The default exposure duration is set equal to the emission duration, which is 1 week (see Emission duration below). The Q-factor is set to 1, because it is based on expert judgement.

Product amount – inhalation
The product amount is calculated as the amount of oil that is depleted during the emission duration of one week. Angulo-Milhem et al. (2020) state that 0.55 g of product is released in 65 hours where the oil needs to be transported by capillary action. The amount of product released in one week would then be 7 × 24 h × 0.55 g / 65 h = 1.4 g. However, the consumer exposure scenario describes that the sticks are sometimes turned, so that the liquid oily product is directly at the interface between the room air and the sticks. Therefore, the product amount is calculated from the emission rates of liquid diffusers. Kim et al. (2018) derived a 75th percentile of 0.17 g/h from 31 liquid diffuser product samples included in the NIER data, whereas Lee et al. (2018) derived a 75th percentile of 0.28 g/h from 5 samples of liquid diffuser products included in the NIER data. The default product amount is calculated from the data of Kim et al. (2018), because these include the higher number of product samples. The emission duration is set to 1 week (see below), so that 7 × 24 × 0.17 = 29 g is evaporated. The default product amount is therefore set to 29 g. The Q-factor is 3, because the underlying emission dataset is large (N=31) but refers to liquid diffusers in general and not specifically to capillary wood or reed diffusers.

Emission duration
The default emission duration is set to 1 week, which refers to the time during which the evaporation of fragrance from the sticks is effective (reeddiffusers.org, 2020). The Q-factor is set to 2, because the default is derived from product information only.

Exposed area
Dermal contact with the fingertips of one hand is expected when the consumer turns around the reed or wood sticks that are submerged in liquid product. The exposed area therefore refers to that of five fingertips, which is calculated from the General Fact Sheet (Te Biesebeek et al., 2014) to be 75 cm^2. (The General Fact Sheet describes a default surface area of a hand to be 450 cm^2 (Te Biesebeek et al., 2014). The surface area of fingers is assumed to be half the surface area of the hand, and the surface area of one finger one-fifth of that, i.e. 45 cm^2, the area of one phalanx 15 cm^2 and of five phalanges 75 cm^2.) The default is thus set to 75 cm^2. The Q-factor is set to 3, because

the underlying data described in the General Fact Sheet (Te Biesebeek et al., 2014) are of high quality but the surface areas of the different parts of the hands that would be in contact with the product are based on assumptions.

Product amount – dermal
The product that ends up on the fingertips of the consumer is a liquid. For liquids it is assumed that a layer 0.01 cm thick may remain on the skin after dermal contact (ECHA, 2015a, 2015b). The exposed area is 75 cm^2 (see above), so that a volume of 0.75 cm^3 ends up on the skin. The base ingredient of reed diffusers is essential oil, which has a density of 0.85 g/cm^3 (reeddifusers.org, 2020). The product amount that ends up on the skin while turning the sticks is therefore about 0.64 g (0.75 cm^3 x 0.85 g/cm^3 ≈0.64 g). The default product amount is rounded and set to 0.6 g. The Q-factor is set to 2, because the data supporting the calculation are limited.

Table 6.16 Default values for estimating consumer exposure to substances released and via dermal contact with reed diffusers

Default value		**Q-factor**	**Source(s)**
General			
Frequency[1]	52 per year	2	Product information
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	1 week	2	Product information
Product amount	29 g	3	Kim et al., 2018
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hr	3	Section 4.6.1
Inhalation rate			
- adult users	0.55 m^3/h	3	Section 4.5.1
- infant bystanders	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	1 week	2	Product information
Dermal–direct product contact–instant application model			
Exposed area	75 cm^2	3	See this section
Product amount	0.6 g	2	See this section

1: Use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. In case the user wants to deviate from one of these defaults, the other defaults need to be corrected for consistency.

6.11 Nebula diffusers

Nebula diffusers are available on the consumer market as devices that diffuse pure essential oils as aerosols that easily evaporate in indoor air. A nebula diffuser forces air flow through a small tube. The velocity of the air flow causes a reduced pressure at the exit point of the device, which creates suction, so that the essential oils rise upwards through a separate glass tube. Subsequently, a stream of pressurised air contacts the oil surfaces and creates micro-droplets that easily evaporate. The result is a nebula of essential oil that disperses through the room air (Angulo-Milhem et al., 2020).

Scenario for consumer exposure
Nebula diffusers are interpreted in this Fact Sheet as electric devices that actively evaporate substances by mechanically creating an air flow. Inhalation exposure is expected when the consumer is present in the room in which a nebula diffuser has been activated. The emission duration of a nebula diffuser depends on the emission programme that the consumer chooses upon activation of the device, which is according to product information between 2 and 10 hours. Dermal exposure can be expected during refilling events, in which the consumer pours the liquid air freshener product from a refill flask into the container of the evaporator device. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to the substances released by the nebula, whereas the ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure while filling the reservoir of the electric evaporator device from either a small flask or a large bottle (see Section 4.4).

6.11.1 *Inhalation of released nebula*
The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to the substances released by the nebula.

Frequency
Nebula diffusers are described in this Fact Sheet as electric air freshener devices with emissions limited to the number of hours set upon activation of the device by the consumer. The EPHECT (2012) survey results indicate that 40% of electric air freshener users use such a device on a daily basis. The default frequency is therefore set to 365 per year. The Q-factor is set to 3, because it is unclear to what extent the large dataset of EPHECT on electric air freshener use (N=952) includes the use of nebula diffusers.

Exposure duration
The default exposure duration is set to 10 hours, which refers to the maximum duration of typical release programmes of a nebula diffuser. The Q-factor is set to 1, because it is assumed that the consumer is present in the room for the entire release programme and then leaves the room afterwards, which is a crude assumption.

Product amount
Experiments performed by the Danish EPA (Lassen et al., 2008) indicate that 40% of a nebula differ device filled with 460 mg of essential oil fill is depleted after 2 hours of device activity, so that 92 mg of product is released every hour. Angulo-Milhem et al. (2021) experimentally determined that 820 mg of product is released when a programme is chosen with medium intensity of release. The duration of the programme was not given. The product amount is set to 920 mg, which is calculated by multiplying the release rate of 92 mg/h according to Lassen et al. (2008) by the maximum emission duration of 10 hours. The Q-factor is set to 1, because it is unclear whether an emission rate of 92 mg/h persists for 10 hours. A Q-factor of 1 is also assigned to the emission duration from which the product amount is calculated.

Emission duration
The default emission duration is set to 10 hours, which refers to the maximum duration of typical release programmes of a nebula diffuser. The Q-factor is set to 1, because the duration is based on product information only.

Table 6.17 Default values for estimating consumer exposure to substances released by nebula diffusers

Default value		**Q-factor**	**Source(s)**
General			
Frequency[1]	365 per year	3	EPHECT, 2012
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	10 hours	1	See this section
Product amount	920 mg	2	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	10 hours	1	See this section

6.11.2 *Refilling*
The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure during a refilling event.

Frequency
Nebula diffusers are expected to be depleted after a maximum emission programme and the exposure scenario states that the consumer is expected to set an emission programme of a nebula diffuser on a daily basis (see Section 6.11.1), so that the default frequency is set to 365 per year. The Q-factor is set to 3, because it is unclear to what extent the large dataset of EPHECT on electric air fresheners use (N=952), from which the frequency is derived, includes nebula diffusers (6.11.1).

Table 6.18 Default values for estimating consumer exposure via skin to substances in nebula diffusers refill events

Default value		**Q-factor**	**Source(s)**
General			
Frequency	365 per year	3	Section 6.11.1
Dermal–direct product contact–instant application model			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

6.12 Potpourri
Potpourri is a traditional air freshener that consists of a dish or open jar filled with a mix of ingredients such as flowers, leaves, herbs and spices that produce a nice smell. An essential or etherical oil is added to strengthen the smell, and other ingredients, such as cellulose grains, plant root, are added to conserve the smell over time(Bhatia et al., 2013).

Scenario for consumer exposure
Potpourri is available on the consumer market as small plastic bags typically containing about 100 g of ingredients. The consumer pours the potpourri from the bag into a dish or jar. The scent of potpourri can last from 2 months to several years. Thus, it is assumed that the products need to be replaced 'about once or twice a year'. The (semi-) volatile substances are assumed to be continuously released into the indoor air (see Section 4.2), because potpourri is composed in such a way that fragrances are gradually released over time (Bhatia et al., 2013). The use of potpourri is not limited to a specific room in the home. The location of the exposure scenario is therefore a non-specified room (see Section 4.6.1). The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances evaporating from potpourri. Handling the potpourri is not included in the scenario as a route for dermal exposure.
It is implicitly assumed that the consumer uninterruptedly stays in the room in which the air freshener is placed for weeks or months, but in reality a consumer enters, remains in and leaves a room within a pattern of daily life activities. Therefore, the exposure scenario can be refined by including a duration of stay parameter (see Annex I).

Frequency
The default frequency refers to the number of times per year the product needs to be replaced (having lost its scent), which is assumed to be 2 per year. The Q-factor is set to 1, because the default is based on expert judgement.

Exposure duration
The default exposure duration refers to the minimal duration after which potpourri products are considered to lose their scent, which is assumed to be 6 months. The Q-factor is set to 1, because the default is based on expert judgement.

Product amount
The product amount refers to the amount of ingredients inside the plastic bag, which is typically 100 g. The Q-factor is set to 1, because the default is derived from only a few the different types of potpourri products available on the consumer market.

Emission duration
The default emission duration is set to 6 months, which refers to the time after which potpourri products are considered to lose scent. The Q-factor is set to 1, because the default is based on expert judgement.

Table 6.19 Default values for estimating consumer exposure to substances released from potpourri

Default value		Q-factor	Source(s)
General			
Frequency[1]	2 per year	1	Product information
Inhalation–exposure to vapour–constant rate model			
Exposure duration[1]	6 months	1	See this section
Product amount	100 g	1	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration[1]	6 months	1	See this section

1: Use frequency, exposure duration and emission duration depend on each other. Frequency (per year) is calculated as the 365 days in a year divided by the emission duration in days, and the exposure duration is set equal to the emission duration. In case the user wants to deviate from one of these defaults, the other defaults need to be corrected for consistency.

6.13 Vacuum cleaner fragrance additives

Vacuum cleaner fragrance additives are available on the consumer market as perfumed sticks, tablets or beads. Vacuum cleaner sticks are about 1 cm in diameter and 2 cm in length. Thye are made of a fabric, e.g. cotton, material that is infused with a liquid fragrance.

Scenario for consumer exposure
According to product information, one vacuum cleaner stick lasts for about six weeks, after which the fragrance substances are exhausted (Wpro, 2020). The consumer opens the packaging by removing a plastic foil and inserts the stick into the dust bag or dust reservoir of the vacuum cleaner. Vacuum cleaner air freshener tablets are used in a similar manner. They are inserted into the dust bag or dust reservoir after the consumer removed plastic foil to activate the scent. New sticks or tablets are needed each time the dust bag is replaced or the dust reservoir is emptied.
Vacuum cleaner air freshener beads or granules are prepared by the consumer by measuring out four capfuls of beads or granules, which are then strewn across the floor (HG, 2020) before the consumer vacuums up the beads. Their scents are then activated each time the vacuum cleaner is activated.
The function of a vacuum cleaner air freshener is twofold: (i) to neutralise bad odours from vacuumed materials in the dust bag or dust reservoir, such as pet hairs, food remains or cigarette ash, and (ii) to release a nice smell each time the consumer uses the vacuum cleaner. The mechanism behind the release of a smell is that the fragrance substances are released inside the dust bag or dust reservoir, where they accumulate until they are blown into the room air each time the vacuum cleaner is turned on. Consequentially, the amount of air freshener product released per vacuum cleaning task depends on the frequency with which the vacuum cleaner is used. The released amount and frequency of vacuuming are correlated, because substances accumulate in the dust bag or reservoir as long as the vacuum cleaner is not activated. Higher amounts are then released per event at relatively low frequencies of

vacuum cleaning. Consequently, short-term inhalation exposure is more intense – i.e. higher peak and mean event concentrations – at a lower frequency of vacuum cleaning events. Long-term inhalation exposure (e.g. year average exposure), however, depends on the number of times per year that scented sticks, tablets or scented granules are inserted into the dust bag. It is assumed that a vacuum cleaner fragrance additive is added each time the dust bag needs to be replaced or dust reservoir needs to be emptied, which is considered to be every 6 weeks (HG, 2020). The year average exposure is proportional to this fixed frequency of product use. The frequency in the exposure scenario refers to the number of vacuum cleaning tasks per year. The product amount released per event is calculated as the fraction of the amount of product that was initially inserted into the dust bag or dust reservoir.
Inhalation exposure is expected during each vacuum cleaning event. The ***inhalation–exposure to vapour–instantaneous release model*** is used to estimate inhalation exposure to substances, because the fragrance substances contained in the air inside the dust bag or dust reservoir are instantly released once the vacuum cleaner is turned on. Handling the vacuum cleaner fragrance additives is not included in the scenario as a route for dermal exposure.

Frequency
The exposure frequency refers to the number of times the consumer uses the vacuum cleaner. A relatively low frequency of vacuum cleaner tasks per year is considered, because the scenario (see above) states that short-term inhalation exposure is more intense at low use frequencies, whereas long-term inhalation exposure does not depend on the number of vacuum cleaning tasks per year. Avershina et al. (2015) performed an assessment among pregnant women and 2-year-olds of exposure to allergens such as dust mites. Part of this exposure assessment was a survey (N=358) in which the frequency of vacuum cleaning was asked. The 25th percentile of the frequency data of Avershina is selected as the default frequency, as this represents a relatively low frequency of 48 per year. The Q-factor is set to 3, because the underlying dataset is large (N=358) and specifically refers to vacuum cleaning frequency. However, it refers to a specific population of pregnant women who are also mothers of a 2-year-old child, and it is not clear to what extent this specific population is representative of all consumers using vacuum cleaner air fresheners.

Exposure duration
There are no data available on the time a consumer spends in the room after the fragrance substances are released by turning on the vacuum cleaner. The exposure duration is set to 4 hours, which is a generic duration for the time spent in a room after a time-limited release event (see Section 4.3). The Q-factor is set to 1, because the default is based on expert judgement.

Product amount
The default product amount refers to the amount of product that is released per vacuum cleaning task. The fragrance substances accumulate in the air inside dust bag or reservoir until it is released into the indoor air when the vacuum cleaner is turned on. It is assumed that the product is completely exhausted once the dust bag needs to be replaced or dust

reservoir needs to be emptied, which is every 6 weeks (i.e. 8.7 times per year) according to product information (HG, 2020). The consumer turns on the vacuum cleaner 48 times per year (see above). It is therefore calculated that 18% of the product amount that is inserted into the dust bag is released each time the vacuum cleaner is turned on (8.7/48 ×100% = 18%). The total weight of the air freshener product inserted into one dust bag is 18 g for granules (HG, 2020), 18 g for sticks (Wpro, 2020) and 22 g for tablets (Kirby, 2020). Hence, the product amount available for inhalation exposure per vacuum cleaner event is 3.3 g (18% × 18 g) for granules and sticks and 4.0 g (18% × 22 g) for tablets. The Q-factors are set to 2 for all product formats, because they are derived from product information.

Table 6.20 Default values for estimating consumer exposure to substances released from vacuum cleaner fragrance additives during vacuum cleaning

Default value		**Q-factor**	**Source(s)**
General			
Frequency	48 per year	3	Avershina et al., 2015
Inhalation–exposure to vapour–instantaneous release model			
Exposure duration	4 hours	1	Section 4.3
Product amount			
- Granules	3.3 g	2	Product information
- Cotton sticks	3.3 g	2	Product information
- Tablets	4.0 g	2	Product information
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hr	3	Section 4.6.1
Inhalation rate			
- *adult users*	1.49 m^3/h	3	Light exercise (see Section 4.5)
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2

7 Toilet air fresheners

Toilet air fresheners are air freshener products that release fragrance substances into the toilet room air to create a pleasant smell or ambiance. Their intended use is limited to the toilet room. Toilet air fresheners included in this Fact Sheet are toilet sprays and toilet rim blocks.

7.1 Toilet sprays

Scenario for consumer exposure
Toilet sprays are available on the market as aerosol spray cans and trigger sprays. The location of the exposure scenario is a toilet room (see Section 4.6.3), where inhalation exposure is expected to be highest when the consumer chooses to use the toilet spray at the start of a toilet visit, in which case the consumer can inhale volatile substances that evaporate from the sprayed droplets. Non-volatile substances in sprayed droplets are available for inhalation exposure as well, because they are small enough to reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017). Substances in droplets too large to pass the nasal region are not inhaled, but orally ingested. Dermal exposure is expected from droplets depositing from the spray cloud onto the unprotected skin of the hands and arms of the consumer.
The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in toilet air freshener sprays, whereas the ***inhalation–exposure to spray–spraying*** model is used to estimate inhalation exposure to non-volatile substances.
There were no data collected that specifically refer to the mass generation rate, airborne fraction, density non-volatiles or particle size distribution of toilet air freshener sprays. The defaults for these parameters are therefore based on the defaults for instant air refreshment sprays in general (see Sections 4.1.1.1 and 4.1.1.2 for aerosol spray cans and for trigger sprays, respectively). Furthermore, the use of toilet sprays is considered to be an air space spraying activity, so that the option to ‘include oral ingestion of non-respirable material’ is offered (4.1.4).
The ***dermal–direct product contact–constant rate model*** is selected for the estimation of dermal exposure from the deposition of droplets from the spray cloud onto the skin of the consumer (4.1.3).

Frequency
The scenario describes the consumer using toilet air freshener spray to mask bad odours in the toilet room at the start of a toilet visit. Ten toilet visits per day is considered to be normal behaviour (see Section 4.6.3), so that a toilet spray is not likely to be used more than 10 times a day. According to the EPHECT (2012) survey, 65% of the consumers who used air freshener sprays (N=1364) used them in the toilet room. Furthermore, 39% of the EPHECT (2012) respondents stated that they used air freshening sprays ‘at least once a day’. Hence, it is considered that air freshener sprays are used in the toilet room at least once a day and at most 10 times a day. However the scenario is based on use of the spray at the start of the toilet visit and this will not be the case for

all toilet visits. Therefore, the default frequency is set to 2 per day, as it is assumed that the consumer needs to mask bad odours for only 2 of the 10 toilet visits a day. The default frequency is therefore set to 2 per day. The Q-factor for this default is set to 2, because the supporting data are limited.

Spray duration
Toilet sprays are used as instant air refreshment sprays. The spray duration is therefore set to 4 s, corresponding to the default duration of home instant air refreshment sprays, with a corresponding Q-factor of 3 (see Section 4.1.1).

Exposure duration
The exposure duration refers to the time the consumer spends on a toilet visit. Toilet visits lasting 5 min are considered normal behaviour (see Section 4.6.3). The default exposure duration is therefore set to 5 min. The Q-factor for this default is set to 2, because the supporting data are limited.

Room volume
Toilet sprays are intended to be used in a toilet room. The default room volume for a toilet room is 2.5 m^3, according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Ventilation rate
The default ventilation rate is set to 2 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 3.

Table 7.1 Default values for estimating consumer exposure to substances in toilet sprays during toilet visits

Default value		**Q-factor**	**Source(s)**
General			
Frequency	2 per day	2	See above
Inhalation–exposure to spray–spraying model			
Spray duration	4 s	3	Section 4.1.1
Exposure duration	5 min	2	Section 4.6.3
Room volume	2.5 m^3	4	Te Biesebeek et al., 2014
Room height	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate	2 per hour	3	Te Biesebeek et al., 2014
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate			
- *aerosol spray cans*	2.0 g/s	2	Section 4.1.1.1
- *trigger sprays*	0.6 g/s	1	Section 4.1.1.2
Airborne fraction			
- *aerosol spray cans*	0.8	2	Section 4.1.1.1
- *trigger sprays*	0.09	1	Section 4.1.1.2
Density non-volatile			
- *aerosol spray cans*	0.96 g/cm^3	1	Section 4.1.1
- *trigger sprays*	0.96 g/cm^3	1	Section 4.1.1
Inhalation cut-off diameter	15 μm	3	Section 4.1.1
Aerosol diameter			
- *aerosol spray cans*			
Median	3.9 μm	2	Section 4.1.1.1
(CV)	(0.65 μm)		
- *trigger sprays*			
Median	2.0 μm	1	Section 4.1.1.2
(CV)	(0.39 μm)		
Inhalation–exposure to spray–instantaneous release model			
Released mass			Spray duration x mass generation rate (Section 4.1.2)
- *aerosol spray cans*	8.0 g	2	
- *trigger sprays*	2.4 g	1	
Dermal–direct product contact–constant rate loading			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray cans*	270 mg/min	3	Section 4.1.3
- *trigger sprays*	180 mg/min	3	Section 4.1.3
Release duration	8 s	3	Twice the spray duration (see Section 4.1.3)

7.2 Toilet rim blocks

Toilet rim blocks are used both to clean the toilet and to release fragrances to create a nice smell in the toilet room. Given these two purposes, toilet rim blocks are described in both the current Air Fresheners Fact Sheet and the Cleaning Products Fact Sheet (Meesters et al., 2018). The scenarios for consumer exposure, selected models, defaults and Q-factors are the same in both Fact Sheets.

Scenario for consumer exposure
The toilet rim block is a ready-to-use product, and no exposure is expected from placing the product inside the toilet. Dermal exposure from handling the toilet rim blocks is therefore not included in this scenario. Toilet rim blocks are designed to constantly provide a fresh smell in the toilet room. Hence, it is assumed that the amount of product that is in the air is constant over time. The consumer will experience inhalation exposure to this steady state air concentration during toilet visits. The ***inhalation–exposure to vapour–instant release model*** is used to calculate the expected inhalation exposure from the steady-state air concentration.

Frequency
The default frequency is set to 365 per year as the default exposure duration refers to the time spent in the toilet room on a daily basis. The Q-factor for this default is set to 4, because a daily toilet visit frequency is considered evident.

Exposure duration
Exposure duration reflects the total duration of daily toilet visits by the consumer. It is considered normal for a person to go to the toilet 10 times a day for 5 min (Heaton et al., 1992; B&B Community, 2017), so that the daily time spent in the toilet room is about 50 min. The default exposure duration is therefore set to 50 min. The Q-factor for this default is 2, because the supporting data are limited.

Product amount
The product amount that is subject to inhalation is interpreted here as the amount of product that is in the air. The air concentration is constant over time, which means that there is a steady-state situation. For such a steady-state situation the amount of product in the air can be calculated from a mass balance equation (Mackay, 2001): $m = E/q$, where m is the amount of product in the air, E is the emission rate of the product to the air and q is the removal rate constant by means of ventilation. The ventilation rate constant in a toilet room is 2 air changes per hour (Te Biesebeek et al., 2014). The emission rate is calculated as the weight of the rim block divided by the service lifetime of the product. According to the Cleaning Products Fact Sheet, a solid rim block weighs 30 g and its service life is 30 days (Prud'homme de Lodder et al., 2006a). The emission rate for solid rim blocks is thus 30 g / 30 days = 1 g/day = 0.042 g/h. The amount of product that is in the air at steady state is thus $m = E/q$ = 0.042 g / 2 g/h = 0.021 g. A liquid rim block contains 70 g of product and has a service life of 60 days (Prud'homme de Lodder et al., 2006a). The emission rate for liquid rim blocks is therefore 70 g / 60 days = 1.17 g/day = 0.049 g/h. The amount of

product that is in the air at steady state is thus *m* = *E/q* = 0.049 g / 2 g/h = 0.024 g.
The Q-factor remains 2, because the supporting data are limited.

Ventilation rate
For this specific calculation the ventilation rate is set to zero to avoid double calculation of the amount of substance removed. Ventilation is the process that removes the product from the air in the toilet room. However, this removal process is already included in the calculation of the steady-state product amount. The Q-factor is set to 3, referring to the default ventilation rate of a toilet room in the General Fact Sheet (Te Biesebeek et al., 2014) used to calculate the steady-state product amount.

Table 7.2 Default values for estimating consumer exposure to substances in toilet rim blocks during toilet visits

Default value		**Q-factor**	**Source(s)**
General			
Frequency	365 per year	4	Daily basis (see above)
Inhalation–exposure to vapour–instantaneous release model			
Exposure duration	50 min	2	See this section
Product amount			
- *liquid rim blocks*	0.024 g	2	See this section
- *solid rim blocks*	0.021 g	2	See this section
Room volume	2.5 m^3	4	Toilet room (Te Biesebeek et al., 2014)
Ventilation rate	0 per hour	3	See this section
Inhalation rate			
- *adult users*	1.49 m^3/h	3	Light exercise (See Section 4.5)
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2

8 Car air fresheners

Car interior air fresheners are marketed for the specific purpose of reducing unpleasant odours and providing a nice smell inside a car. Car air fresheners come in distinct formats, such as paper fresheners infused with fragrance which can be hung inside the car, air fresheners that work with the car's ventilation system or low-voltage electrical fresheners to plug into the car's socket for electronic devices (EC, 2010).

8.1 Car interior air sprays

Scenario for consumer exposure
The consumer enters the car and sprays with the car interior air spray for a few seconds throughout the entire interior of the car. Next the consumer goes for a drive and inhales non-volatile and volatile substances in the sprayed product. Dermal exposure is expected as well as spray droplets deposit upon unprotected skin of the consumer. The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances, whereas the ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in car sprays.
There were no data collected that specifically refer to the *airborne fraction*, *density non-volatile* and *aerosol diameter* of car sprays. The defaults for these parameters are therefore based on those of air freshener sprays in general (see Section 4.1.1). Furthermore, the use of car interior sprays is considered to be an air space spraying activity, so that the option to 'include oral ingestion of non-respirable material' is selected (4.1.4). The ***dermal–direct product contact–constant rate model*** is selected for the estimation of dermal exposure from the deposition of droplets from the spray cloud onto the skin of the consumer (4.1.3).

Frequency
The frequency of exposure refers to how often the consumer uses the car interior air freshener spray before a car journey. From the NIER data Kim et al. (2018) give a 75th percentile use frequency for car spray of 8 times per month, which is equal to 96 per year. The default frequency is set to 96 per year on the basis of these data. The Q-factor is set to 2, because the number of respondent answers in the underlying dataset from which the 75th percentile for the frequency of using car sprays is derived is unclear.

Spray duration
Kim et al. (2018) indicate that consumers spray for about 3 s when they use a trigger or aerosol spray can to freshen up the interior air of a car. The EPHECT (2012) dataset refers to a spray duration of '3 to 4 s' for general use of instant refreshment sprays (see Section 4.1). The default spray duration for car sprays is therefore set to 3 s, as this matches the specific use of sprays in cars as described in Kim et al. (2018) and also agrees with the EPHECT (2012) dataset for spraying instant refreshment sprays in general. The Q-factor is set 4, because the underlying dataset

is large and, in the case of the NIER data, specifically refers to the spray duration of car sprays.

Table 8.1 Default values for estimating consumer exposure to substances from spraying car interior air sprays

Default value		**Q-factor**	**Source(s)**
General			
Frequency	96 per year	2	Kim et al., 2018
Inhalation–exposure to spray–spraying model			
Spray duration[1]	3 s	3	Kim et al., 2018
Exposure duration[2]	60 min	2	Section 4.6.2
Room volume[2]	2.4 m^3	3	Section 4.6.2
Room height[1]	1.5 m	3	Section 4.6.2
Ventilation rate[2]	1.5 per hour	3	Section 4.6.2
Inhalation rate[2]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	2.0 g/s	2	Section 4.1.1.1
- *trigger spray*	0.6 g/s	1	Section 4.1.1.2
Airborne fraction[1]			See this section
- *aerosol spray can*	0.8	2	Section 4.1.1.1
- *trigger spray*	0.09	1	Section 4.1.1.2
Density non-volatile[1]			
- *aerosol spray can*	0.96 g/cm^3	1	Section 4.1.1.1
- *trigger spray*	0.96 g/cm^3	1	Section 6.1
Inhalation cut-off diameter[1]	15 µm	3	Section 4.1.1
Aerosol diameter[1]			
- *aerosol spray can*			
Median (CV)	3.9 µm (0.65)	2	Section 4.1.1.1
- *trigger spray*			
Median (CV)	2.0 µm (0.39)	1	Section 4.1.1.2
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- *aerosol spray can*	6.0 g	2	
- *trigger spray*	1.8	1	
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray can*	270 mg/min	3	Section 4.1.3
- *trigger spray*	180 mg/min	3	Section 4.1.3
Release duration	6 s	3	Twice the spray duration

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

Mass generation rate
The default mass generation rates for car interior sprays are the same as the mass generation rates generically derived for instant air refreshment sprays available as aerosol spray cans or trigger sprays, which are 2.0 and 0.6 g/s, respectively (see Sections 4.1.1.1 and 4.1.1.2).

Airborne fraction
The default airborne fractions (including scaling factor) for car interior sprays are the same as the airborne fractions generically derived for instant air refreshment sprays available as aerosol spray cans or trigger sprays, which are 0.8 and 0.09, respectively (see Sections 4.1.1.1 and 4.1.1.2).

Aerosol diameter
The default aerosol diameters for car interior air sprays are the same as the aerosol diameters generically derived for instant air refreshment sprays available as aerosol spray cans or trigger sprays. These are characterised by a lognormal distribution with a median diameter of 3.9 µm and a CV of 0.65 for aerosol spray cans and a median diameter of 2.0 µm and a CV of 0.39 for trigger sprays (see Sections 4.1.1.1 and 4.1.1.2).

8.2 Electric evaporators

Scenario for consumer exposure
It is assumed that the electric air freshener evaporator is constantly plugged in, so that the device is automatically activated upon ignition of the engine and stopped when the engine is switched off. The product amount available for inhalation exposure refers to the amount of liquid product emitted during a 1-hour car journey (see Section 4.6.2). The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released from the electric evaporator into the car interior air. Dermal exposure can be expected during refilling events, in which the consumer must pour air freshener product from a refill flask or bottle into a small reservoir in the electric evaporator device. The ***dermal–direct product contact–instant application model*** is used to estimate dermal exposure for these events (Meesters et al., 2018). Inhalation exposure during refilling events is considered to be negligible compared with the inhalation exposure from evaporation.

8.2.1 *Electric evaporation*

Frequency
The frequency of exposure refers to how often the consumer is in a car as either a driver or a passenger, which is set to 365 per year to represent a daily basis (CBS, 2020). The Q-factor is set to 2, because it is assumed that the device is activated during each car journey.

Product amount
Product information indicates that electric evaporators for car interiors emit 3.2 ml of product in 240 hours (SC Johnson, 2021). The density of car plug-in evaporator product is about 0.98 g/ml (SC Johnson, 2019), so that 13 mg is released per hour ((3.2 ml × 0.98 g/ml) / 240 hours). The default product amount available for inhalation is thus set to 13 mg, because the emission duration is 1 hour (see below). The Q-factor is set to 2, because the underlying data derive from product information (glade.com, 2020) and mobility data (CBS, 2020).

Emission duration
The device is active for the entire car journey, so that the emission duration is set to 60 min, which is equal to the exposure duration (see Section 4.6.2), the Q-factor for this default is set to 2, which is equal to the Q-factor of the exposure duration.

Table 8.2 Default values for estimating consumer exposure to substances in electric evaporators for cars

Default value		**Q-factor**	**Source(s)**
General			
Frequency	365 per year	2	See this section
Inhalation–exposure to vapour–constant rate model			
Exposure duration	60 min	2	Section 4.6.2
Product amount	13 mg	2	See this section
Room volume	2.4 m^3	3	Section 4.6.2
Ventilation rate	1.5 per hour	3	Section 4.6.2
Inhalation rate[1]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	60 min	2	Section 4.6.2

8.2.2 *Refilling*

Frequency
The frequency of exposure refers to how often the consumer needs to refill the reservoir of the car air freshener. Product information indicates that electric car air fresheners are exhausted after 240 hours of use (SC Johnson, 2021). At a driving frequency of 1 hour per day (see above; CBS, 2020), the product will be exhausted after 240 days. Therefore, the reservoir needs be refilled 1.5 times per year, which is set as the default frequency for refilling. The Q-factor is set to 2, because the underlying data derive from product information (SC Johnson, 2021) and mobility data (CBS, 2020).

Table 8.3 Default values for estimating consumer exposure to substances in electric evaporators for cars during refilling events

Default value		**Q-factor**	**Source(s)**
General			
Frequency	1.5 per year	2	See this section
Dermal–direct product contact–instant application model			
Exposed area	53 cm^2	2	Section 4.4
Product amount	0.53 g	3	Section 4.4

8.3 Fragrance-infused items

Scenarios for consumer exposure
Fragrance-infused items consist of a porous solid material that is submerged in a liquid or oily air freshener product from which fragrances evaporate into the interior of the car. The consumer places a fragrance-infused item in a central place in the car such as the dashboard or below the rear-view mirror. Fragrance-infused items are passive diffusers that continuously release fragrance substances until the product is exhausted. Therefore, the release continues even if the consumer is not inside the car. However, data from Ott et al. (2008) show that when the doors of the car are opened, there is a significant and rapid exchange of the air in

the vehicle. A draft of ambient outdoor air replaces the indoor air when the consumer enters the car (Ott et al., 2008). It is therefore assumed that any air concentration during the absence of the consumer in the car is reduced to a negligible level the moment the consumer opens the door to enter the car. It is acknowledged that the consumer may be exposed to air concentration in the car when the door is opened; however, this peak exposure is expected to be very short-lived given the rapid air exchange from opening a car door and therefore negligible when compared with the direct exposure from the fragrance-infused item during driving.
Air concentrations are built up again during the car journey, when the doors are closed. The release of substances is not interrupted during the car journey, so that the emission duration is also considered to be 1 hour. The product amount available for inhalation exposure refers to the amount of liquid or oily product that is released from the porous solid material. The porous solid material itself is not considered to be part of the product amount that is available for inhalation. Rather, the solid material is regarded as a vessel from which the actual product, i.e. the liquid or oil, is released. Consequently, weight fractions of substances that are to be evaluated should refer to the amount of the substance as a fraction of the amount of liquid or oil that is in the item. The ***inhalation–exposure to vapour–constant rate model*** is used to estimate inhalation exposure to substances released from the fragrance-infused items into the car interior air.

Frequency
The frequency of exposure refers to how often the consumer is in a car either as a driver or passenger, which is set to 365 per year to represent a daily basis (CBS, 2020). The Q-factor is set to 2, because it is assumed that the device is activated during each car journey

Product amount
Product information states that a solid item of 6 g is impregnated with about 2 ml of scent oil (unilite.co.uk, 2021). Essential oil has a density of 0.85 g/cm^3 (reeddifusers.org, 2020), so that the fragrance-infused items contain 2 ml × 0.85 g/cm^3 = 1.7 g oil. A fragrance-infused car air freshener lasts for about 30 days (freshproducts.com, 2021), so that 2.4 mg of oil is emitted during an one-hour car journey. The default product amount is therefore set to 2.4 mg. The Q-factor is set to 1, because the default is calculated from different sources of product information

Emission duration
The infused items passively evaporate substances for the entire car journey, so that the emission duration is set to 60 min, which is equal to the exposure duration (see Section 4.6.2). The Q-factor for this default is set to 2, which equates to the Q-factor of the exposure duration.

Table 8.4 Default values for estimating consumer exposure to substances in fragrance-infused items for cars during car journeys

Default value		**Q-factor**	**Source(s)**
General			
Frequency	365 per year	2	CBS, 2020
Inhalation–exposure to vapour–constant rate model			
Exposure duration	60 min	2	Section 4.6.2
Product amount	2.4 mg	1	See this section
Room volume	2.4 m^3	3	Section 4.6.2
Ventilation rate	1.5 per hour	3	Section 4.6.2
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Emission duration	60 min	2	See this section

9 Fabric fresheners

Fabric fresheners are consumer products that are applied to a fabric in order to eliminate and cover any unpleasant odours. They are also used to create a scent that is perceived by the consumer as pleasant or as an alternative to the scent of the fabric. Fabric fresheners included in this Fact Sheet are clothing sprays (textile freshener sprays), interior fabric sprays and scented carpet powders.

9.1 Clothing sprays

Scenarios for consumer exposure
The consumer applies clothing spray to a piece of clothing to eliminate bad odours or to add a specific scent. The spray bottle is held upright during the spraying event, which involves a sweeping motion across the clothing item. During spraying the consumer holds up the clothing item with one hand, so that the spray is also directed towards the holding hand. It is assumed that the consumer uses the spray to treat three items consecutively. During such a spraying activity, the consumer can inhale volatile substances evaporating from the sprayed droplets. Non-volatile substances in sprayed droplets small enough to reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017), are available for inhalation exposure as well. The spray activity is interpreted as a general surface or item spraying, because the spray is directed towards the clothing item. The option to 'include oral ingestion of non-respirable material' is not selected, because the droplets that are too large to pass the nasal region are expected to deposit onto the treated clothing item. Dermal exposure is expected from droplets depositing from the spray cloud onto the unprotected skin of the hands and arms of the consumer.
The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances, whereas the ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in clothing sprays. The ***dermal–direct product contact–instant application model*** is selected for estimation of dermal exposure to the deposited sprayed droplets on the hand of the consumer holding the clothing items.
Dermal exposure is also anticipated from wearing clothes treated with a clothing spray, as substances migrate from the textile to the skin of the consumer. The ***dermal–direct product contact–migration model*** is used to estimate such dermal exposure.

Frequency
Product information on clothing sprays claims that the sprays can be used whenever the consumer wishes, but also suggest limiting excessive usage on clothing articles between laundering (Dettol, 2020). The reason for using clothing sprays is to cover bad smells from clothes that have not been washed for some time. The Cleaning Products Fact Sheet (Meesters et al., 2018) states that laundry is washed every day; this statistic is based on the Norwegian survey data of Laitala et al. (2012), which also indicate that 22% of respondents found that odours had

‘often’ or ‘sometimes’ not disappeared from clothing after washing. It is therefore assumed that on 22% of the days in the year the consumer wears a clothing item that needs treatment with a clothing spray. The frequency of textile freshener spray use is thus set to 80 per year (22% x 365 per year). The Q-factor is set to 1, because of the expert judgement assumption that the percentage of respondents experiencing bad smells in washed clothing items is equal to the use frequency of clothing sprays.

9.1.1 *Spraying*

Spray duration
The scenario states that three items are treated by the consumer. Product information for a textile freshener available as a trigger spray (Dettol, 2020) states that about three trigger pulls is sufficient to effectively refresh one clothing item. The trigger of a clothing spray can be pulled about 10 times in approximately 5 s (Kim et al., 2020), so that 1 pull is performed in approximately 0.5 s. The consumer needs to pull the trigger 9 times in this scenario, so that the default spray duration for trigger sprays is 9 × 0.5 s = 4.5 s.
There is, however, no information available on the number of pump presses the consumer needs to perform to treat the same clothing items with a pump spray. It is therefore assumed that the amount of textile freshener product needed to freshen up clothing items is the same for pump and trigger sprays, because both comprise a liquid product with a comparable composition of ingredients. Kim et al. (2020) investigated the mass generation of a trigger clothing spray and a pump clothing spray. The pump spray generated about 1.7 g in approximately 5 s, whereas the trigger spray generated about 8.5 g in approximately 5 s. Therefore, it takes 5 times longer to obtain the same product amount with a pump spray. The default spray duration for pump sprays is therefore set to 5 × 4.5 s = 22.5 s. The Q-factors for the spray durations for pump and trigger sprays are set to 2, because the underlying data are limited.
There are also no data available for the spray duration required to freshen up clothing items with an aerosol spray can. The spray duration to freshen up clothing items with an aerosol spray can is therefore assumed to be equal to that of a trigger spray. The default spray duration for aerosol spray cans is thus 4.5 s, but the Q-factor is set to 1 because of this assumption.

Spray duration – aerosol spray cans
The default spray duration to treat clothing items with an aerosol spray can is set to 4.5 s (see Spray duration above). The Q-factor is set to 1, because the assumption that the spray duration is equal to that of a trigger spray is based mainly on expert judgement.

Spray duration – pump sprays
The default spray duration of pump sprays used to treat clothing items is set to 22.5 s. The Q-factor is set to 2, because it is derived from the number of trigger pulls described in product information (see Spray duration above).

Spray duration – trigger spray
The default spray duration for trigger sprays is set to 4.5 s. The Q-factor is set to 2, as it is calculated from the number of pulls indicated by product information (see Spray duration above).

Exposure duration
There are no data available on the time a consumer spends in the room after treating clothing items with a textile freshener spray. The exposure duration is therefore set to 4 hours, which refers to a generic duration for the time spent in a room upon a time-limited release event (see Section 4.3). The Q-factor is set to 1, because the default is based largely on expert judgement.

Mass generation rate
Kim et al. (2020) investigated the mass generation of a trigger clothing spray and a pump clothing spray. The pump spray generated 1.687 g in approximately 5 s, whereas the trigger spray generated 8.495 g in approximately 5 s.
The default mass generation rate is therefore set to 0.34 g/s for pump sprays and 1.7 g/s for trigger sprays. Delmaar & Bremmer (2009) determined 0.5 g/s as a mass generation rate for a textile freshener aerosol spray can. The default mass generation rate for aerosol spray cans is therefore set to 0.5 g/s. The Q-factors for all three mass generation rates are set to 3, because the underlying datasets refer to the specific products but only include one pump spray, one trigger spray and one aerosol spray can as product samples.

Airborne fraction
Clothing sprays are used at a 20–30 cm distance from the items that need to be treated (Dettol, 2020; HG, 2020; Kim et al., 2020), which is interpreted here as general surface or object spraying. The airborne fraction for spray products used in such a manner is 0.2 (Delmaar & Bremmer, 2009). The sprayed product comprises droplets <22.5 μm, so that a scaling factor needs to be considered (see Section 4.1). The scaling factor (i.e. the mass fraction of droplets <22.5 μm) is determined by Delmaar & Bremmer (2009) to be 0.1 for pump sprays. Therefore, the default for the scaled airborne fraction used here is 0.2 × 0.1 = 0.02. For trigger sprays the scaling factor is 0.09 (see Section 4.1.1.5), resulting in a default (scaled) airborne fraction of 0.2 × 0.09 = 0.018. The scaling factor for an aerosol spray can is 1 (4.1.1.3), so that the default airborne fraction is 0.2 ×1 = 0.2. The Q-factor for all three defaults is set to 1, because the underlying data are limited and do not directly refer to clothing sprays.

Density non-volatile
Clothing sprays are used as odour mask sprays. The default density of non-volatile substances in clothing sprays that operate as trigger or pump sprays is therefore set to 1.13 g/cm^3 (see Section 4.1.1). The density of non-volatile ingredients in odour mask aerosol spray cans is set to 1.1 g/cm^3 (4.1.1). The Q-factors are set to 2, because the number of data samples is limited.

Aerosol diameter
Kim et al. (2020) characterised the aerosol diameter of trigger textile sprays and pump textile sprays. However, their data give only concentrations of droplets up to 10 µm, whereas ConsExpo (Web) requires the mass median diameter and CV over the entire size spectrum of sprayed droplet sizes (Delmaar & Schuur, 2017). Therefore, it is not possible to insert the measured aerosol diameters of Kim et al. (2020) in ConsExpo (Web). The default aerosol diameter for clothing sprays available as aerosol spray cans, pump sprays and trigger sprays is therefore based on the generic aerosol diameters for odour cover sprays (see Sections 4.1.1.3–4.1.1.5).

Aerosol diameter – aerosol spray can
The default aerosol diameter for clothing sprays available in aerosol spray cans is set to of a textile freshener spray measure by Tuinman et al. (2004). As such, the default aerosol diameter fits a lognormal distribution with a median diameter of 76 µm and a CV of 1.76 (see Section 4.1.1.3). The Q-factor is set to 1, because it is derived from only one product sample.

Aerosol diameter – pump spray
For pump clothing sprays the aerosol diameter of eau de toilette is taken (see Section 4.1.1.4). The default aerosol diameter of clothing sprays available as pumps is therefore set at a median diameter of 2.7 µm and a CV of 0.73 µm, with a Q-factor of 1 because the underlying datapoints do not refer to a textile freshener pump spray.

Aerosol diameter – trigger spray
The aerosol diameter of a trigger clothing spray is conservatively estimated from a trigger-operated fine plant spray (Delmaar & Bremmer, 2009), for which the combination of aerosol diameter and the scaling of the airborne fraction yields the most effective inhalation of droplets of all trigger spray defaults (see Section 4.1.1.5). Therefore, the default aerosol diameter of trigger sprays is set to a median diameter of 2.0 µm and a CV of 0.39 µm, with a Q-factor of 1 because the underlying datapoints do not refer to a textile freshener pump spray.

Released mass
The released mass for volatile substance is calculated by multiplying the mass generation rate of the spray by the spray duration. Thus, the default released mass is 7.7 g for pump and trigger sprays (0.34 g/s × 22.5 s and 1.7 g/s × 4.5 s, respectively) and 2.3 g for aerosol spray cans (0.5 g/s × 4.5 s). The Q-factors are set to 2 for pump and trigger sprays and to 1 for aerosol spray cans, because of the limited quality of the spray durations from which the released masses are calculated (see Spray duration above).

Product amount – dermal
The consumer holds up the clothing items with one hand while spraying, so that the spray is also directed towards the holding hand. Bremmer et al. (2006a) provide a default for dermal exposure due to spraying with hair spray, assuming that 90% of the spray ends up on the head (hair and skin), whereas 10% misses the hair and ends up on the scalp. Adopting a similar approach for spraying towards a hand holding a

clothing item yields a product amount subject to dermal exposure of 0.77 g (10% of a released mass of 7.7 g) for pump and trigger sprays and 0.23 g (10% of 2.3 g, see above) for aerosol spray cans. The defaults are thus set to 0.77 g for pump and trigger sprays and 0.23 g for aerosol spray cans. The Q-factors are set to 1, because of the crude assumptions in the calculation.

Table 9.1 Default values for estimating consumer exposure to substances in clothing spray during spraying

Default value		**Q-factor**	**Source(s)**
General			
Frequency	80 per year	1	Section 9.1
Inhalation–exposure to spray–spraying model			
Spray duration[1] - *aerosol spray can* - *pump spray* - *trigger spray*	 4.5 s 22.5 s 4.5 s	 1 2 2	Kim et al., 2020; Product information
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	20 m^3	4	Section 4.6.1.
Room height[1]	2.5 m	4	Section 4.6.1.
Ventilation rate[2]	0.6 per hour	3	Section 4.6.1.
Inhalation rate[2] - *adult users*	 0.55 m^3/h	 3	 Section 4.5.1.
Mass generation rate[1] - *aerosol spray can*	 0.5 g/s	 3	 Delmaar & Bremmer, 2009
- *pump spray*	0.34 g/s	3	Kim et al., 2020
- *trigger spray*	1.7 g/s	3	Kim et al., 2020
Airborne fraction[1] - *aerosol spray can* - *pump spray* - *trigger spray*	 0.2 0.02 0.018	 1 1 1	 See this section See this section Section 4.1.1.2
Density non-volatile[1] - *aerosol spray can* - *pump spray* - *trigger spray*	 1.1 g/cm^3 1.13 g/cm^3 1.13 g/cm^3	 2 2 2	 Section 4.1.1. Section 4.1.1. Section 4.1.1.
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV) - *aerosol spray can*	 76 µm (1.76)	 1	 Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.5
Inhalation-exposure to spray-instantaneous release model			
Released mass[3] - *aerosol spray can* - *pump spray* - *trigger spray*	 2.3 g 7.7 g 7.7 g	 1 2 2	Spray duration x mass generation rate
Dermal–direct product contact–instant application model			

Default value		Q-factor	Source(s)
Exposed area	450 cm^2	4	One hand (Te Biesebeek et al., 2014)
Product amount			
- *aerosol spray can*	0.23 g	1	See this section
- *pump spray*	0.77 g	1	See this section
- *trigger spray*	0.77 g	1	See this section

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

9.1.2 *Dermal migration from clothes treated with textile spray*

The ***dermal–direct product contact–migration model*** is used to estimate dermal exposure from substances migrating from clothing treated with a textile air freshener.

Exposed area
The exposed area from wearing clothes treated with a clothing spray is considered to be the area of the total body minus the head and hands (Meesters et al., 2018). According to the General Fact Sheet (Te Biesebeek et al., 2014), the exposed area of an adult calculated as above is 1.7 m^2. The Q-factor is set to 4 given the high quality of the underlying data.

Product amount
The product amount refers to the weight of the clothes worn by the consumer. In a small experiment (Prud'homme de Lodder et al., 2006a), individuals were asked to weigh their clothes (except shoes). Winter clothes worn simultaneously weigh 1382 g. Summer garments were estimated at 932 g (by excluding the sweater that is worn over a T-shirt during winter). The default product amount is set to 1000 g. The Q-factor is set to 2, because the supporting data are limited.

Leachable fraction
The leachable fraction in this case is interpreted as the fraction of a substance in the clothing spray product able to leach from clothes to the skin of the person wearing them. Because of a lack of data on clothing sprays, it is assumed that 50% of the amount of substance that is sprayed onto the clothes is available for migration. The assumption of 50% is consistent with the expert judgement of Prud'homme de Lodder et al. (2006a) for the migration of laundry product in washed clothes. Thus, the leachable fractions (FR_{leach}) are to be calculated from the amount sprayed ($g_{sprayed}$) and the weight of the piece of textile ($g_{textile}$):

$$FR_{leach} = \frac{g_{sprayed}}{g_{textile}} \times 50\% \times W_f$$

For pump and trigger sprays, the leachable fraction is thus 7.7 g / 1000 g × 50% x W_f = 0.0038 x W_f. For aerosol spray cans the leachable fraction is 2.3 g / 1000 g × 50% × W_f = 0.0012 × W_f. The Q-factor is set to 1, because the assumption that 50% of the substance is available for migration is conservative and based on expert judgement.

Skin contact factor
The skin-contact factor (F_{skin}) is the fraction of the product that is actually in contact with bare skin. For the calculation of F_{skin}, it is assumed that half of the clothes are in constant contact with the skin (F_{skin}=1) and half of the clothes have intermittent contact with the skin (F_{skin}=0.6, Prud'homme de Lodder et al., 2006a). Overall, the skin contact factor becomes 0.5 × 1 + 0.5 × 0.6 = 0.8 (Prud'homme de Lodder et al., 2006a). Therefore, the default for the skin contact factor is set to 0.8. The Q-factor is set to 1, because the calculation depends largely on expert judgement.

Table 9.2 Default values for estimating consumer exposure to substances in clothing spray migrating from clothing

Default value		**Q-factor**	**Source(s)**
General			
Frequency	80 per year	1	Section 9.1.1
Dermal–direct product contact–migration model			
Exposed area	1.7 m^2	4	Meesters et al., 2018; Te Biesebeek et al., 2014
Product amount	1000 g	2	Prud'homme de Lodder et al., 2006a
Leachable fraction[1]			
- *aerosol spray can*	0.0012 x W_f	1	See this section
- *pump spray*	0.0038 x W_f	1	See this section
- *trigger spray*	0.0038 x W_f	1	See this section
Skin contact factor	0.8	1	Prud'homme de Lodder et al., 2006a

1 W_f = weight fraction of the substance in the clothing spray

9.2 Interior fabric sprays

Generic scenario for consumer exposure
The consumer uses interior fabric sprays to eliminate bad odours from large pieces of fabric that are part of the interior of the home, such as bedding, curtains, tablecloths, furnishings and rugs (HomeFirst, 2020). They are also used to create a scent that is perceived by the consumer as pleasant or as an alternative to the scent of the fabrics themselves. Fabric spray products are suitable for use on a daily basis (Dettol, 2020; HomeFirst, 2020). The uses that may lead to consumer exposure refer to the multi-purpose applications of interior fabric sprays. For each spray application the spray is handled in the same manner with respect to the amount of spray used per area of fabric (g sprayed/m^2 fabric), the distance between the spray nozzle and the item treated, and the characterisation of the spray's mass generation rate and aerosol diameter. During the spraying activity, the consumer can inhale volatile substances that evaporate from the sprayed droplets. Non-volatile substances in sprayed droplets are inhaled as well, as they are small enough to reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017).
The spraying activity is interpreted as a general surface or item spraying, because the spray is directed towards the interior fabric. The option to 'include oral ingestion of non-respirable material' is not selected, because the droplets that are too large to pass the nasal region are expected to

deposit onto the treated fabric. Dermal exposure is expected from droplets depositing from the spray cloud onto the unprotected skin of the hands and arms of the consumer.
The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in fabric sprays, whereas the ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances. The 'spraying towards person' option is not considered relevant as the spray is directed towards the fabric and not the person. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of dermal exposure to droplets depositing from the spray cloud onto the skin of the consumer.

Additional scenarios for consumer exposure
Default parameter values are described below for the spray events of interior fabric spray applications to freshen up (i) carpets and rugs, (ii) curtains, (iii) bed sheets, and (iv) furnishings. Additional dermal exposure is expected for two of the four spray applications: (i) a rug or carpet is an accessible surface for small children, such that they may be dermally exposed by rubbing off the product from the carpet and (ii) substances sprayed onto bed sheets may migrate onto the skin of the consumer while sleeping. The ***dermal–direct product contact–rubbing-off loading model*** is used to estimate dermal exposure by rubbing off substance sprayed onto carpets and rugs by crawling infants. In addition, the ***oral–direct product contact–direct oral intake model*** is used to calculate oral exposure that may result from hand-to-mouth behaviour during or after the rubbing-off activity (Meesters et al., 2018, section 4.3.2). The ***dermal–direct product contact–migration model*** is used to estimate dermal exposure from substances migrating from bed sheets that have been treated with interior fabric spray.

Amount of spray used per area of fabric
It is assumed that all fabric spray applications require a similar amount of spray per area of fabric (see below).The default parameter values for spray duration, released mass and release duration are indirectly calculated from the scenario of fabric spray used to freshen up clothes by assuming that the amount of spray used per area of fabric (g sprayed/m^2 fabric) is similar for clothing and other fabrics. Product information states that about three trigger pulls is sufficient to effectively refresh one clothing item with a trigger spray (Dettol, 2020). A T-shirt is assumed to be representative of the treated clothing item, so that the fabric area treated with three trigger pulls is equal to that of an adult trunk and upper arms. According to the General Fact Sheet (Te Biesebeek et al., 2014) the default surface area of an adult trunk is 0.66 m^2 and the area of adult arms 0.26 m^2, so that the area of the upper arms only is estimated to be 0.26 m^2/2 = 0.13 m^2. Therefore, the fabric area of a T-shirt is considered to be 0.66 + 0.13 = 0.79 m^2. The amount of spray used to treat three clothing items was derived to be 7.7 g for pump and trigger sprays and 2.3 g for aerosol spray cans (see Section 9.1.1). Hence, the amount needed to treat one clothing item is 7.7/3 = 2.6 g for trigger and pump sprays and 2.3/3 = 0.77 g for aerosol spray cans. The amount of spray used per area of fabric is then 2.6/0.79 = 3 g/m^2 for trigger sprays and pump sprays and 1 g/m^2 for aerosol spray cans. Any defaults derived from these *amounts sprayed per area of fabric* are

assigned a Q-factor of 1, because the assumption that the amount of spray needed per area for clothing also applies to other fabrics is based on expert judgement.

9.2.1 *Carpet and rug spraying*

The scenario states that the consumer treats the fabric of a carpet or rug. The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances in interior fabric sprays. The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in fabric sprays. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of dermal exposure to droplets depositing from the spray cloud onto the skin of the consumer. The default parameter values for mass generation rate, airborne fraction, density non-volatile and aerosol diameter are not described below, because they are the same as those for fabric spray used to freshen up clothes (see Section 9.1.1).

Frequency

Data on how often consumers use carpet or rug sprays are not available. Therefore, it is assumed that the frequency of cleaning a carpet or rug is similar to that of treating a carpet's bad smell. The Cleaning Products Fact Sheet (Meesters et al., 2018) describes a frequency of 52 per year for treating a carpet with a cleaning product, with a Q-factor of 4 based on the survey data of Garcia-Hidalgo et al. (2017). The default frequency for treating a carpet with interior fabric spray is therefore set to 52 per year. The Q-factor is, however, set to 1, because the frequency does not refer to the treatment of carpets or rugs with interior fabric spray.

Spray duration

The amount of spray used to treat 1 m^2 of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2). It is assumed that the carpet or rug covers the entire living room floor, so that the area to be treated is 22 m^2 (Te Biesebeek et al., 2014). Thus, 66 g of spray product is needed when using a trigger or pump spray and 22 g when using an aerosol spray can. Given the mass generation rates of the sprays of 1.7 g/s, 0.34 g/s and 0.5 g/s (see Section 9.1.1), the respective default spray durations are 44 s, 195 s and 39 s, for a trigger spray, a pump spray and an aerosol spray can. The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Exposure duration

The use of carpet and rug sprays is considered to be a time-limited release event, so that the exposure duration refers to a generic exposure duration of 4 hours with a Q-factor of 1 (see Section 4.3).

Room volume

The object to be treated is considered to be the largest piece of fabric in the home, which is a carpet or rug covering the entire area of the living room. The default room volume is therefore that of a living room, which according to the General Fact Sheet is 58 m^3 (Te Biesebeek et al., 2014), with a Q-factor of 4.

Ventilation rate
The default ventilation rate of a living room is 0.5 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Released mass
The released mass for volatile substances is calculated by multiplying the mass generation rate of the spray (see Section 9.1.1) by the spray duration. Therefore, the default released mass is 66 g for pump and trigger sprays and 22 g for aerosol spray cans (see Spray duration above). The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Table 9.3 Default values for estimating consumer exposure to substances in interior fabric spray during the spraying of carpets and rugs (table continues on next page)

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Garcia Hidalgo et al., 2017
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- *aerosol spray can*	44 s	1	See this section
- *pump spray*	195 s	1	See this section
- *trigger spray*	39 s	1	See this section
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	58 m^3	4	Te Biesebeek et al., 2014
Room height[1]	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate[2]	0.5 per hour	3	Te Biesebeek et al., 2014
Inhalation rate[2]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	0.5 g/s	3	Section 9.1.1
- *pump spray*	0.34 g/s	3	Section 9.1.1
- *trigger spray*	1.7 g/s	3	Section 9.1.1
Airborne fraction[1]			
- *aerosol spray can*	0.2	1	Section 9.1.1.
- *pump spray*	0.02	1	Section 9.1.1
- *trigger spray*	0.018	1	Section 4.1.1.5
Density non-volatile[1]			
- *aerosol spray can*	1.1 g/cm^3	2	Section 4.1.1
- *pump spray*	1.13 g/cm^3	2	Section 4.1.1
- *trigger spray*	1.13 g/cm^3	2	Section 4.1.1
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *aerosol spray can*	76 µm (1.76)	1	Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.5

Default value		Q-factor	Source(s)
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- aerosol spray can	22 g	1	
- pump spray	66 g	1	
- trigger spray	66 g	1	
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- aerosol spray can	100 mg/min	2	Section 4.1.3
- pump spray	40 mg/min	1	Section 4.1.3
- trigger spray	46 mg/min	3	Section 4.1.3
Release duration			Twice the spray duration
- aerosol spray can	88 s	1	
- pump spray	390 s	1	
- trigger spray	78 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

9.2.1.1 Rubbing-off from sprayed rugs by crawling infants

The carpet that is treated with fabric spray is an accessible surface for small children, who may be dermally exposed by rubbing off the product from the carpet. The scenario of secondary exposure of crawling infants rubbing off substances from treated carpets that is described in the Cleaning Products Fact Sheet (Meesters et al., 2018) also applies to carpets treated with odour cover sprays. The secondary exposure is therefore estimated using the ***dermal–direct product contact–rubbing-off loading model***. The ***oral–direct product contact–direct oral intake model*** is used to calculate oral exposure from hand-to-mouth behaviour (Meesters et al., 2018). The exposed population group specifically refers to infants at the age when they typically crawl, i.e. 6-12 months (see Section 4.5.3).

Exposed area

The Cleaning Products Fact Sheet (Meesters et al., 2018) states that dermal exposure of a crawling child to a substance via rubbing-off can take place on any uncovered part of the skin, e.g. head, arms, hands, legs or feet. The exposed area is based on a one-year-old child wearing a T-shirt and shorts, a nappy and no socks or shoes (Meesters et al., 2018, section 4.3.1). The covered skin area (trunk) is 35.7 % (Te Biesebeek et al., 2014), so that the exposed area can be calculated as the uncovered fraction of the total body surface of a one-year-old child: 64.3% x 0.45 m^2 = 0.29 m^2 (Te Biesebeek et al., 2014). The default for the exposed area is therefore set to 0.3 m^2 with a Q-factor of 4, because the default specifically refers to the unprotected skin area of a child derived from a large dataset.

Contacted surface
The contacted surface (S_{area}) is the area of the treated surface that can be rubbed off, which is in this scenario a carpet on the floor of a living room covering an area of 22 m^2 (Te Biesebeek et al., 2014). The default is thus set to 22 m^2 with a Q-factor of 4 in accordance with the General Fact Sheet (Te Biesebeek et al., 2014).

Dislodgeable amount
The dislodgeable amount is the amount of product applied to a contacted surface area that is potentially rubbed off per unit of surface area. It is calculated by multiplying the product amount (g) per m^2 by 0.3 (Meesters et al., 2018). The amount of product sprayed per area of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2). Hence, the dislodgeable amount is 0.3 × 3 = 0.9 g/m^2 for pump and trigger sprays and 0.3 × 1 g/m^2 = 0.3 g/m^2 for aerosol spray cans. The Q-factor is set to 1, because the default dislodgeable amount is calculated from the *amounts sprayed per area of fabric*, for which a Q-factor of 1 is given (9.2).

Transfer coefficient
The transfer coefficient is described by the US-EPA (1997, 2012) as ‘a measure of surface-to-skin residue transfer dependent on factors such as surface type and contact intensity’. Another definition is ‘the ratio of exposure, measured in mass of chemical per time (e.g. µg/hr), to residue, measured in mass of chemical per surface area (e.g. µg/cm^2), with resulting units cm^2/hr’. The Cleaning Products Fact Sheet (Meesters et al., 2018) describes a transfer coefficient of 0.2 m^2/hr derived from the recommendations of HEAdhoc (2016) with a Q-factor of 3.

Contact time
It is assumed that a 6–12-month-old child crawls over a cleaned floor for 1 hour a day. The default contact time is therefore 60 min, with a Q-factor of 2 (Prud’homme de Lodder et al., 2006a; Meesters et al., 2018).

Amount ingested
The amount ingested is calculated as 10% of the total external dermal dose (Bremmer et al., 2006b). The hands are the part of the body for which the highest exposure per cm^2 is expected, because they are most likely to touch the substance. In this scenario, the infant touches the carpet with bare hands while crawling over it. The bare hands form about 20% of the total uncovered skin. If it is assumed that 50% of the product that ended up on the hands is taken in orally due to hand-to-mouth contact, this means that 10% of the external dermal dose is ingested via hand-mouth contact (Bremmer et al., 2006b). The Q factor is set to 1, because the default is based on expert judgement.

Table 9.4 Default values for estimating consumer exposure to substances in interior fabric sprays from rubbing-off sprayed carpets or rugs

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Section 9.2.1
Dermal–direct product contact–rubbing-off model			
Exposed area	0.29 m^2	4	Meesters et al., 2018
Transfer coefficient	0.2 m^2/hr	3	Meesters et al., 2018
Dislodgeable amount			
- *aerosol spray can*	0.3 g/m^2	1	See this section
- *pump spray*	0.9 g/m^2	1	See this section
- *trigger spray*	0.9 g/m^2	1	See this section
Contact time	60 min	2	Prud'homme de Lodder et al., 2006a; Meesters et al., 2018
Contacted surface	22 m^2	4	Te Biesebeek et al., 2014
Oral–direct product contact–direct oral intake model			
Amount ingested	10% of total external dose; 50% of dose on hands	1	Bremmer et al. 2006b

9.2.2 *Curtain spraying*

Frequency

It is assumed that the use frequency of interior fabric spray to treat curtains is comparable to that for treating carpets. The frequency is therefore set to 52 per year (see Section 9.2.1). The Q-factor is set to 1, because the default is based on an expert judgement assumption.

Spray duration

The amount of spray used to treat 1 m^2 of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2). The area of fabric that needs treatment refers to the curtains in a living room. The height of the curtains is estimated to be 2.5 m, being the default height of a living room (Te Biesebeek et al., 2014). Furthermore, the Cleaning Products Fact Sheet (Meesters et al., 2018, section 12.1) assumes that a 22m^2 living room consists of a short side of 4 m and a long side of 5.5 m. The surface area of the curtain fabric is therefore considered to be (4 m + 5.5 m) × 2.5 m = 24 m^2. Hence, 24 m^2 × 3 g/m^2 = 72 g of spray product is needed to treat the curtains with a trigger or pump spray, whereas 24 m^2 × 1 g/m^2 = 24 g is needed for treatment with an aerosol spray can. Given the mass generation rates of the sprays of 1.7 g/s, 0.34 g/s and 0.5 g/s (see Section 9.2), the respective default spray durations are 42s, 206 s and 48 s for a trigger spray, a pump spray and an aerosol spray can. The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Exposure duration

The spraying with curtain sprays is considered to be a time-limited release event, so that the exposure duration refers to a generic exposure duration of 4 hours with a Q-factor of 1 (see Section 4.3).

Room volume
The largest area of curtains is situated in the living room of the house. The default room volume therefore refers to that of a living room, which, according to the General Fact Sheet (Te Biesebeek et al., 2014), is 58 m^3, with a Q-factor of 4.

Ventilation rate
The default ventilation rate of a living room is 0.5 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Released mass
The released mass for volatile substances is calculated by multiplying the mass generation rate of the spray by the spray duration. Thus, the default released mass is 72 g for pump and trigger sprays, and 24 g for aerosol spray cans (see Spray duration above). The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Release duration
The release durations for dermal deposition are calculated as twice the spray durations (see Section 4.1.3), leading to default values of 84 s, 410 s and 96 s for trigger sprays, pump sprays and aerosol spray cans, respectively. The Q-factor of 1 for spray duration (see above) also applies to the release duration.

Table 9.5 Default values for estimating consumer exposure to substances in interior fabric sprays during the spraying of curtains (table continues on next page)

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Section 9.2.1
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- *aerosol spray can*	48 s	1	See this section
- *pump spray*	205 s	1	See this section
- *trigger spray*	84 s	1	See this section
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	58 m^3	4	Te Biesebeek et al., 2014
Room height[1]	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate[2]	0.5 per hour	3	Te Biesebeek et al., 2014
Inhalation rate[1]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	0.5 g/s	3	Section 9.1.1
- *pump spray*	0.34 g/s	3	Section 9.1.1
- *trigger spray*	1.7 g/s	3	Section 9.1.1
Airborne fraction[1]			
- *aerosol spray can*	0.2	1	Section 9.1.1
- *pump spray*	0.02	1	Section 9.1.1
- *trigger spray*	0.018	1	Section 9.1.1
Density non-volatile[1]			

Default value		Q-factor	Source(s)
- *aerosol spray can*	1.1 g/cm^3	2	Section 4.1.1
- *pump spray*	1.13 g/cm^3	2	Section 4.1.1
- *trigger spray*	1.13 g/cm^3	2	Section 4.1.1
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *aerosol spray can*	76 µm (1.76)	1	Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.5
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- *aerosol spray can*	24g	1	
- *pump spray*	72 g	1	
- *trigger spray*	72 g	1	
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray can*	100 mg/min	2	Section 4.1.3
- *pump spray*	40 mg/min	1	Section 4.1.3
- *trigger spray*	46 mg/min	3	Section 4.1.3
Release duration			Twice the spray duration
- *aerosol spray can*	96 s	1	
- *pump spray*	410 s	1	
- *trigger spray*	168 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

9.2.3 *Furniture spraying*

Frequency

There are no data available on treating furniture with interior fabric sprays. Therefore, it is assumed that the frequency of cleaning furniture is also representative of the frequency of spraying furniture to treat bad odours. From the survey of Garcia-Hidalgo et al. (2017) it can be derived that cleaning furniture ‘once a week’ is representative for the 75th percentile. Thus, the default frequency for treating furniture with interior fabric spray is set to 52 per year. The Q-factor is set to 1, as the default frequency does not refer to the treatment of furniture with interior fabric spray.

Spray duration

The amount of spray used to treat 1 m^2 of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2). The area of furniture fabric that needs to be treated is estimated to be 5.5 m^2. This is in accordance with the exposure scenarios for the furniture maintenance products included in the Cleaning Products Fact Sheet, describing the treatment of a 5.5 m^2 sofa situated in a living room (Meesters et al., 2018). Hence, the amounts of spray needed to treat furniture are 5.5 m^2 × 3 g/m^2 = 16.5 g for a trigger or pump spray, and 5.5 m^2 ×1 g/m^2 = 5.5 g for an aerosol spray can. Given the mass generation rates of the sprays of 1.7 g/s, 0.34 g/s and 0.5 g/s (9.1.1), the resulting default spray durations are 10 s, 50 s and 11 s, for a trigger spray, a pump spray and an aerosol spray can, respectively. The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Exposure duration
The use of furniture refreshment sprays is considered to be a time-limited release event, so that the exposure duration refers to a generic exposure duration of 4 hours with a Q-factor of 1 (see Section 4.3).
Room volume
The treated furniture is considered to be situated in the living room. The default room volume is 58 m^3 according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Ventilation rate
The default ventilation rate of a living room is 0.5 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Released mass
The released mass for volatile substance is calculated by multiplying the mass generation rate of the spray by the spray duration. Thus, the default released mass is 17 g for pump and trigger sprays and 5.5 g for aerosol spray cans (see Spray duration above). The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Release duration
The release durations for dermal deposition are calculated as twice the spray durations (see Section 4.1.3). The default values are 20 s, 100 s and 22 s for trigger sprays, pump sprays and aerosol spray cans, respectively. The Q-factor of 1 for the spray duration (see above) also applies to the release duration.

Table 9.6 Default values for estimating consumer exposure to substances in interior fabric sprays during the spraying of furniture (table continues on next page)

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	See this section
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- *aerosol spray can*	11 s	1	See this section
- *pump spray*	50 s	1	See this section
- *trigger spray*	10 s	1	See this section
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	58 m^3	4	Te Biesebeek et al., 2014
Room height[1]	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate[2]	0.5 per hour	3	Te Biesebeek et al., 2014
Inhalation rate[2]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1

Default value		Q-factor	Source(s)
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	0.5 g/s	3	Section 9.1.1
- *pump spray*	0.34 g/s	3	Section 9.1.1
- *trigger spray*	1.7 g/s	3	Section 9.1.1
Airborne fraction[1]			
- *aerosol spray can*	0.2	1	Section 9.1.1
- *pump spray*	0.02	1	Section 9.1.1
- *trigger spray*	0.018	1	Section 9.1.1
Density non-volatile[1]			
- *aerosol spray can*	1.1 g/cm^3	1	Section 4.1.1
- *pump spray*	1.13 g/cm^3	1	Section 4.1.1
- *trigger spray*	1.13 g/cm^3	1	Section 4.1.1
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *aerosol spray can*	76 µm (1.76)	1	Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 9.1.1
- *trigger spray*	2.0 µm (0.39)	1	Section 9.1.1
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- *aerosol spray can*	5.5 g	1	
- *pump spray*	16.5 g	1	
- *trigger spray*	16.5 g	1	
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray can*	100 mg/min	2	Section 4.1.3
- *pump spray*	40 mg/min	1	Section 4.1.3
- *trigger spray*	46 mg/min	3	Section 4.1.3
Release duration			Twice the spray duration
- *aerosol spray can*	22 s	1	
- *pump spray*	100 s	1	
- *trigger spray*	20 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

9.2.4 *Bed sheets spraying*

Frequency
The default frequency is set to 52 per year, because it is assumed that the frequency of using interior fabric spray for bed sheets is comparable to that for carpet, curtains and furniture. The Q-factor is set to 1, because the default is based on an expert judgement assumption.

Spray duration
The amount of spray used to treat 1 m^2 of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2). The area of fabric that needs to be treated is calculated for a double bed and includes the upper and lower side of a duvet fit for two persons (2 x 2 x 1 m x 2 m = 8 m^2) and the area of a fitted bed sheet for two persons (2 x 1 m x 2 m = 4 m^2). Therefore, a

total of 12 m^2 of fabric area is to be treated. Thus, 12 m^2 x 3 g/m^2 = 36 g of spray product is needed for a trigger or pump spray, whereas 12 m^2 x 1 g/m^2 = 12 g is needed for an aerosol spray can. Given the mass generation rates of the sprays of 1.7 g/s, 0.34 g/s and 0.5 g/s (9.1.1), the respective default spray durations are 21 s, 105 s and 24 s, for a trigger spray, a pump spray and an aerosol spray can. The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Exposure duration
The exposure duration is set to 8.5 hours, referring to the 8.5 hours of sleep described in the General Fact Sheet (Te Biesebeek et al., 2014). The Q-factor is set to 4 given the quality of the underlying data.

Room volume
The default room volume is 16 m^3, referring to that of a bedroom (see General Fact Sheet, Te Biesebeek et al., 2014), with a Q-factor of 4.

Ventilation rate
The default ventilation rate of a bedroom is 1 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 3.

Released mass
The released mass for volatile substance is calculated by multiplying the mass generation rate of the spray by the spray duration. Thus, the default released mass is 36 g for pump and trigger sprays and 12 g for aerosol spray cans (see Spray duration above). The Q-factor is set to 1, because of the expert judgement-based assumptions made in the derivation of the default spray duration.

Release duration
The release durations for dermal deposition are calculated as twice the spray durations, resulting in values of 42 s, 210 s and 48 s for trigger sprays, pump sprays and aerosol spray cans, respectively. The Q-factor of 1 for the spray duration (see above) also applies to the release duration.

Table 9.7 Default values for estimating consumer exposure to substances in interior fabric sprays during the spraying on bed sheets (table continues on next page)

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Section 9.2.1
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- aerosol spray can	24 s	1	See this section
- pump spray	105 s	1	See this section
- trigger spray	21 s	1	See this section
Exposure duration[2]	8.5 hour	4	Te Biesebeek et al., 2014
Room volume[2]	16 m^3	4	Te Biesebeek et al., 2014
Room height[1]	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate[2]	1 per hour	3	Te Biesebeek et al., 2014

Default value		Q-factor	Source(s)
Inhalation rate[2]	0.55 m^3/h	3	Section 4.5.1
Mass generation rate[1]			
- *aerosol spray can*	0.5 g/s	3	Section 9.1.1
- *pump spray*	0.34 g/s	3	Section 9.1.1
- *trigger spray*	1.7 g/s	3	Section 9.1.1
Airborne fraction[1]			
- *aerosol spray can*	0.2	1	Section 9.1.1
- *pump spray*	0.02	1	Section 9.1.1
- *trigger spray*	0.018	1	Section 4.1.1.5
Density non-volatile[1]			
- *aerosol spray can*	1.1 g/cm^3	2	Section 4.1.1
- *pump spray*	1.13 g/cm^3	2	Section 4.1.1
- *trigger spray*	1.13 g/cm^3	2	Section 4.1.1
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *aerosol spray can*	76 µm (1.76)	1	Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.5
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- *aerosol spray can*	12 g	1	
- *pump spray*	36 g	1	
- *trigger spray*	36 g	1	
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2	3	Section 4.1.3
Contact rate			
- *aerosol spray can*	100 mg/min	2	Section 4.1.3
- *pump spray*	40 mg/min	1	Section 4.1.3
- *trigger spray*	46 mg/min	3	Section 4.1.3
Release duration			
- *aerosol spray can*	48 s	1	Twice the spray duration
- *pump spray*	210 s	1	
- *trigger spray*	42 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

9.2.4.1 Migration from bed sheets

It is assumed that the consumer has sprayed the fabric spray over the fitted sheet cover and the duvet cover before going to bed. While the consumer is sleeping, substances in the fabric spray may migrate from the bed sheets to the skin of the consumer. The ***dermal–direct product contact–migration model*** is selected for the estimation of dermal exposure.

Exposed area

The exposed area is the full body of an adult. The default body area for adults is 1.82 m^2 in the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Product amount

The default product amount refers to the weight of the bed sheets that are in dermal contact with the consumer. The contact area is derived to be 4 m^2 as the consumer is in contact with the underside of the duvet cover (1 m × 2 m = 2 m^2) plus the upper side of the fitted sheet cover (1 m × 2m = 2 m^2). The surface area of cotton is about 20 cm^2 per g, so that 1 m^2 of fabric weighs about 500 g (Corea et al., 2006; Meesters et al., 2018). The weight of the bed sheets is thus 4 m^2 × 500 g/m^2 = 2000 g. The default product amount is therefore also 2000 g. The Q-factor is set to 1, because the default is derived from expert judgement.

Leachable fraction
The leachable fraction is interpreted here as the fraction of a substance in the fabric spray product that can leach from the bed sheets to the skin of the person sleeping in the bed. Because of a lack of data on fabric sprays, it is assumed that 50% of the amount of substance that is sprayed onto the sheets is available for migration. The assumption of 50% is consistent with the expert judgement of Prud'homme de Lodder et al. (2006a) for the migration of laundry product in washed clothes. Therefore, the leachable fractions are calculated as a function of the weight fraction of the substance in the product (W_f):

$$FR_{leach} = \frac{g_{sprayed}}{g_{textile}} \times 50\% \times W_f$$

The amount of product sprayed per area of fabric is calculated to be 3 g/m^2 for trigger and pump sprays and 1 g/m^2 for aerosol spray cans (see Section 9.2), so that the amount of spray product used is 4 m^2 × 3 g/m^2 = 12 g for trigger and pump sprays and 4 m^2 × 1 g/m^2 = 4 g for aerosol spray cans. The leachable fraction for pump and trigger sprays is thus 12 g/2000 g × 50% × W_f = 0.003 × W_f and for aerosol spray cans 4 g/2000 g × 50% × W_f = 0.001 W_f. The Q-factor is set to 1, because the assumption that 50% of the substance is available for migration is conservative and based on expert judgement.

Skin contact factor
The default for the skin contact factor is set to 1, assuming that the full body of the consumer is in contact with the bed sheets treated with fabric spray. The Q-factor is set to 1, because the default is based on expert judgement.

Table 9.8 Default values for estimating consumer exposure to substances in interior fabric sprays migrating from bed sheets

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Section 9.2.4
Dermal–direct product contact–migration model			
Exposed area	1.82 m^2	4	Full body area (Te Biesebeek et al., 2014)
Product amount	2000 g	1	See this section
Leachable fraction[1]			See this section
- *aerosol spray can*	0.002 X W_f	1	See this section
- *pump spray*	0.006 X W_f	1	See this section
- *trigger spray*	0.006 X W_f	1	See this section
Skin contact factor	1	1	See this section

[1] W_f = weight fraction of the substance in the product

9.2.5 *Scented carpet powders*

Scenarios for consumer exposure

Scented carpet powders have the function to remove bad odours from carpets and to provide a nice smell. The way scented carpet powder is handled by the consumer is similar to the handling of carpet powders with a cleaning function, as described in the Cleaning Products Fact Sheet (Meesters et al., 2018 – section 11.2.2). The consumer directly scatters the powder from the packaging onto the surface to be treated. The powder is therefore scattered over an area of 22 m^2 in the living room (Te Biesebeek et al., 2014). Directly after scattering, the consumer brushes the powder into the carpet's fibre structure. Dermal exposure is expected during brushing via hand contact. Next, the powder is left on the carpet for a period of 20 min for the product to absorb liquids, emulsify dirt or trap substances that release bad odours. Inhalation exposure is anticipated during leave-on, because volatile substances in the powder evaporate from the carpet. After leave-on, the powder is removed with a vacuum cleaner. Secondary exposure is anticipated, because the treated carpet is accessible to small children and residues may still be present after vacuum cleaning. Carpet powders mainly consist of volatile substances (Meesters et al., 2018). Therefore, the ***inhalation–exposure to vapour–evaporation–increasing release area model*** is used to estimate inhalation exposure to carpet powders. For the estimation of dermal exposure, the ***dermal–direct product contact–constant rate model*** is used.

9.2.5.1 Scattering scented carpet powders

Frequency

The default frequency of using scented carpet powder is considered to be 52 per year based on the use frequency of carpet cleaning powder in the Cleaning Products Fact Sheet (Meesters et al., 2018), which was derived from the data of Garcia-Hidalgo et al. (2017). Therefore, the default frequency is set to 52 per year with a Q-factor of 4.

Application duration

The application duration is interpreted here as the time required for the consumer to scatter and brush the powder into the carpet's fibre structure. The application duration of scented carpet powder is set to 11 min, which is based on the application duration of carpet cleaning powder in the Cleaning Products Fact Sheet (Meesters et al., 2018). The Q-factor is 2, because the supporting data are not available (Meesters et al., 2018).

Exposure duration
The exposure duration is interpreted here as the time required for the consumer to scatter and brush the powder over the carpet (application duration of 11 min) plus a leave-on period of approximately 20 min (Vanish, 2020). Hence, the default exposure duration is set to approximately 30 min. The Q-factor is 2, because the supporting data are limited (Meesters et al., 2018).

Product amount – inhalation
The product amount that is subject to inhalation is calculated as the amount of powder that is scattered over the carpet. The first Cleaning Products Fact Sheet (Prud'homme de Lodder et al., 2006a) prescribed a default of 50–100 g per m^2, which is still in accordance with recent product information (Meesters et al., 2018; Vanish, 2020). The carpet area is 22 m^2, corresponding to 2200 g of powder scattered. The default product amount that is subject to inhalation is thus 2.2 kg. The Q-factor is set to 2, because the supporting data are limited.

Molecular weight matrix
The fraction of water in the carpet powder is estimated to be 0.4 (Meesters et al., 2018). Following the conservative approach, the default molecular weight matrix is calculated as the molecular weight of water (18 g/mol) divided by the fraction of water in the product (0.4), which yields 45 g/mol. The Q-factor is 2, because the supporting quantitative data are limited.

Contact rate
It is assumed that the contact rate of 2.8 mg/min, derived for scattering powders over cracks and crevices in a kitchen and treating skirting boards, shelves and laminate surfaces (ECHA, 2015a), also applies to the scattering of powder over a carpet. The default contact rate for the use of scented carpet powder is thus set to 2.8 mg/min. The Q factor is set to 1, because it is unclear whether dermal contact from the scattering of powders is comparable to dermal contact from the brushing of scattered powders.

Table 9.9 Default values for estimating consumer exposure to substances in scented carpet powder during scattering

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	4	Meesters et al., 2018
Inhalation–exposure to vapour–evaporation–increasing release area model			
Exposure duration	30 min	2	Meesters et al., 2018
Molecular weight matrix	45 g/mol	2	Meesters et al., 2018
Product amount	2200 g	2	Meesters et al., 2018
Room volume	58 m^3	4	Living room (Te Biesebeek et al., 2014)
Ventilation rate	0.5 per hour	3	Living room (Te Biesebeek et al., 2014)
Inhalation rate	1.49 m^3/h	3	Light exercise (See 4.5)
Application temperature	20 °C	4	Room temperature
Mass transfer coefficient	10 m/h	2	Meesters et al., 2018
Release area	22 m^2	4	Living room floor (Te Biesebeek et al., 2014)
Application duration	11 min	2	See this section
Dermal–direct product contact–constant rate model			
Exposed area	225 cm^2	3	Hand palms (Te Biesebeek et al., 2014)
Contact rate	2.8 mg/min	1	ECHA, 2015a
Release duration	11 min	2	Application duration

9.2.5.2 Rubbing-off of scented carpet powder by crawling infants

Carpet that is treated with scented carpet powder is an accessible surface for small children, who may be dermally exposed by rubbing off the product from the carpet. This form of secondary exposure is estimated using the ***dermal–direct product contact–rubbing-off model***. The ***oral–direct product contact–direct oral intake model*** is used to calculate oral exposure from hand-to-mouth behaviour (Meesters et al., 2018).

Contacted surface

The contacted surface (S_{area}) is the area of treated surface that can be rubbed, which in this scenario is the floor area of a living room, i.e. 22 m^2 (Te Biesebeek et al., 2014). The default is thus set to 22 m^2 in accordance with the General Fact Sheet (Te Biesebeek et al., 2014), with a Q-factor of 4.

Dislodgeable amount

The dislodgeable amount ($F_{dislodge}$) is calculated by multiplying the fraction of product that is dislodgeable in generic rubbing-off exposure scenarios, which is by default 0.3 (Meesters et al., 2018), by the amount of product scattered per area (g/m^2) (Meesters et al., 2018). The carpet is vacuum cleaned after treatment with carpet powder. There are no data available about the amount of residue that remains on the carpet after vacuum cleaning. It is thus conservatively assumed that 10% of the product amount is still on the carpet after vacuum cleaning (Meesters et al., 2018). Hence, the dislodgeable amount is 0.3 × (2200g / 22 m^2) x 10%

= 3 g/m^2. The Q-factor is set to 1, because the assumption of 10% residue after vacuum cleaning is based on expert judgement.

Contact time
It is assumed that a 12-month-old child crawls over a cleaned floor for 1 hour a day. The default contact time (t) is therefore 60 min, with a Q-factor of 2 (Prud'homme de Lodder et al., 2006a).

Table 9.10 Default values for estimating consumer exposure to substances in scented carpet powder by rubbing-off

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	4	Meesters et al., 2018
Dermal–direct product contact–rubbing-off model			
Exposed area	0.3 m^2	4	Meesters et al., 2018
Transfer coefficient	0.2 m^2/hr	3	Meesters et al., 2018
Dislodgeable amount	3 g/m^2	1	Meesters et al., 2018
Contact time	60 min	2	Prud'homme de Lodder et al., 2006a
Contacted surface	22 m^2	4	Living room floor (Te Biesebeek et al., 2014)
Oral–direct product contact–direct oral intake model			
Amount ingested	10% of total external dose; 50% of dose on hands	1	Bremmer et al., 2006b

10 Animal odour mask products

Animal odour mask products are consumer products that are used to treat objects or surfaces that smell bad because of the presence of a pet. Bad odours from urine stains, hair, dander or sweat are eliminated or masked by these products, which release substances into the room air to create a pleasant scent or ambiance, so that bad smells are less perceived. The animal odour mask products included in this Fact Sheet are pet urine odour remover sprays, foams and liquids; and pet odour sprays.

10.1 Pet urine odour remover sprays

Scenarios for consumer exposure
Pets that are not house-trained may leave urine stains on carpets. To sanitise the stains and to mask the bad smells from the urine, a consumer can use pet urine odour remover spray. Odour remover sprays are available as pump and trigger sprays. User directions of pet urine odour remover sprays indicate that urine stains need to be saturated with the spray product in order to effectively remove the urine crystals that are the source of the odour (UrineOff, 2020). Thus, the volume of the sprayed product is considered to be equal to the volume of urine in the stain. Large pets with large bladders thus require more spray product to be used. Dogs are therefore considered the most exemplary domestic animal for a conservative exposure scenario relating to the treatment of pet urine stains, because they are relatively large and are well known to urinate in the home on account of old age, behavioural problems or medical conditions. The location of the exposure scenario is set to an unspecified room (Te Biesebeek et al., 2014), because a pet urine stain is not limited to a specific room but may occur in any (carpeted) room of the house (see Section 4.6.1). The consumer treats a urine stain by spraying the product onto it until it is completely saturated. Then the product is left to soak up the urine and then dry. After the soaking period the consumer rinses off the stain with water. Inhalation exposure is expected during the spraying activity, as the consumer can inhale volatile substances that evaporate from the sprayed droplets. Non-volatile substances in sprayed droplets small enough to reach the lower areas of the lungs, i.e. the alveolar region (Delmaar & Schuur, 2017), are available for inhalation exposure as well. Substances in droplets too large to pass the nasal region are not inhaled. The use of pet urine odour remover sprays is considered to be a general surface spraying activity, so that the option to ‘include oral ingestion of non-respirable material’ is not offered by default (4.1.4). Dermal exposure is expected from droplets depositing from the spray cloud onto the unprotected skin of the hands and arms of the consumer. The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances, whereas the ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in pet urine odour remover sprays. The ‘spraying towards person’ option is considered not relevant as the spray is directed towards the stain and not the person. The mass generation rate, airborne fraction and aerosol diameter are set equal to those of fabric freshener sprays (9.1 and 9.2),

because the function and intended use of both products is comparable, i.e. the consumer sprays them onto a fabric and substances soak into the fabric to eliminate, trap and mask bad odours. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of the dermal exposure to droplets from the spray cloud that are deposited onto the skin of the consumer. The consumer may touch the spray product after the soaking period while cleaning up the stain by rinsing and brushing. The ***dermal–direct product contact–instant application model*** is selected for the estimation of such dermal exposure.

Frequency
An incidental pet urine stain on a carpet is a reason to clean the carpet. The Cleaning Products Fact Sheet (Meesters et al., 2018) gives a frequency of 52 per year for treating a carpet with a cleaning product, based on the survey data of Garcia-Hidalgo (2017), with a Q-factor of 4. The default frequency for treating pet urine stains on a carpet is therefore set to 52 per year as a conservative estimate. The Q-factor is, however, set to 1, because it is unclear how often the consumer in the original survey of Garcia-Hidalgo (2017) cleans a carpet because of an incidental urine stain from a pet.

10.1.1 *Spraying*
The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in fabric sprays, whereas the ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of the dermal exposure to droplets from the spray cloud that are deposited on the skin of the consumer.

Spray duration
The spray duration is calculated from the amount of product that is required to treat the stain and the mass generation rate of the spray. Product information states that a urine stain needs to be saturated with the product in order to effectively eliminate the odour (UrineOff, 2020). Thus, it is assumed that the volume of product used is equal to the volume of urine excreted by the dog. Scientific publications in the field of veterinary science indicate that 0–1-year-old dogs release about 50 ml of urine at one time (Atalan et al., 1999; Karthikraj & Kannan, 2019). The density of urine eliminator is about 1 g/ml (Clorox, 2019), so that 50 g of product is needed to treat the dog urine stain. The mass generation rate of an odour mask trigger spray is set to 1.7 g/s and that of a pump spray to 0.34 g/s (see Sections 4.1.1.4 and 4.1.1.5), so that the default spray duration is set to 50 g/1.7 g/s = 30 s for trigger sprays and 50 g/0.34 g/s = 150 s for pump sprays. The Q-factor is set to 1, because the derivation of the defaults depends largely on expert judgement.

Exposure duration
Product information (Nature's Miracle, 2020) states that after the stain is treated it needs to dry for 24 hours. It is assumed that the consumer spends 4 of these 24 hours in the same room after the stain is treated. These 4 hours refer to the time the consumer may spend in a room uninterruptedly to perform leisure activities (see Section 4.3). The Q-factor is set to 1, because the default is derived from expert judgement.

Released mass
The released mass for volatile substances is considered to be equal to the amount of product used. Therefore, the default released mass is set to 50 g (see Spray duration above). The Q-factor is set to 1, because the derivation of the defaults depends largely on expert judgement.

Table 10.1 Default values for estimating consumer exposure to substances in pet urine spray during spraying

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Garcia-Hidalgo et al., 2017
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- *pump spray*	150 s	1	See this section
- *trigger spray*	26 s	1	See this section
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	20 m^3	4	Section 4.6.1
Room height[1]	2.5 m	4	Section 4.6.1
Ventilation rate[2]	0.6 per hour	3	Section 4.6.1
Inhalation rate[2]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *pump spray*	0.34 g/s	1	Section 4.1.1.4
- *trigger spray*	1.7 g/s	1	Section 4.1.1.5
Airborne fraction[1]			
- *pump spray*	0.02	1	Section 4.1.1.4
- *trigger spray*	0.018	1	Section 4.1.1.5
Density non-volatile[1]	1.13 g/cm^3	2	Section 4.1.1
Inhalation cut-off diameter[1]	15 μm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *pump spray*	2.7 μm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 μm (0.39)	1	Section 4.1.1.5
Inhalation–exposure to spray–instantaneous release model			
Released mass[3]	50 g	1	See this section
Dermal–direct product contact–constant rate model			
Exposed area	2200 cm^2		Section 4.1.3
Contact rate			
- *pump spray*	40 mg/min	1	Section 4.1.3
- *trigger spray*	46 mg/min	3	Section 4.1.3
Release duration			
- *pump spray*	300 s	1	Twice the spray duration
- *trigger spray*	52 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

10.1.2 *Stain rinsing*

The ***dermal–direct product contact–instant application model*** is selected for the estimation of dermal exposure from the rinsing of the urine stain.

Exposed area

The exposed area is considered to be the top phalanges of all five fingers of one hand. The General Fact Sheet gives a default surface area of a hand of 450 cm^2 (Te Biesebeek et al., 2014). The surface area of fingers is 225 cm^2, assuming that they represent half the surface area of the hand. The surface area of one finger is then 45 cm^2, one phalanx is 15 cm^2 and five phalanges is 75 cm^2. The default is thus set to 75 cm^2. The Q-factor is set to 3, because the underlying data described in the General Fact Sheet (Te Biesebeek et al., 2014) are of high quality but are lowered by the calculation described above.

Product amount

It is assumed that the amount per cm^2 applied to treat the stain is equal to the amount per cm^2 on the exposed skin area of the consumer. The exposed skin area is calculated as five fingertips, because the rest of the hand is protected by the cloth. The area of stain that needs to be treated is considered to be 1000 cm^2 (Meesters et al., 2018), so an amount of product of 50 g/1000 cm^2 = 0.05 g/cm^2 is needed. The exposed skin area is considered to be 75 cm^2, referring to the area of five fingertips (see above). The default product amount that is subject to dermal exposure is thus calculated as 0.05 g/cm^2 x 75 cm^2 = 3.75 g. The Q-factor is 1, because of the expert judgement-based assumption that the amount per cm^2 applied to the stain is equal to the amount per cm^2 on the exposed skin.

Table 10.2 Default values for estimating consumer exposure to substances in pet urine spray during stain rinsing

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	Section 10.1.1
Dermal–direct product contact–instant application model			
Exposed area	75 cm^2	3	See this section
Product amount	3.75 g	1	See this section

10.2 Pet urine odour remover foams

The consumer uses a spray can that contains a foam product to treat the urine stain on a carpet in an unspecified room. The surface area of the urine stain is 0.1 m^2 according to the Cleaning Products Fact Sheet (Meesters et al., 2018). Product information states that the foam needs to soak into the stain for 30 min (Nature's Miracle, 2020). Inhalation exposure is anticipated during the leave-on period, as volatile substances may evaporate from the applied product. Next, the consumer treats the carpet stain with (paper) towels, and the surface is patted dry. Dermal exposure is expected from rubbing the carpet or upholstery with the towels. The ***inhalation–exposure to vapour–evaporation–constant release area model*** is used to estimate inhalation exposure to substances evaporating during the time the foam is left to soak. Dermal exposure from wiping and patting with towels is estimated using the ***dermal–direct product contact–instant application model***.

Frequency
The frequency refers to the number of times per year the consumer needs to treat an incidental urine stain on a carpet. The default frequency for treating pet urine stains on a carpet is set to 52 per year based on the frequency of generic carpet cleaning (see Section 10.1). The Q-factor is set to 1, because the default is based on expert judgement.

Exposure duration
The spraying of pet urine odour remover foam is considered to be a time-limited release event, so that the exposure duration refers to a generic exposure duration of 4 hours with a Q-factor of 1 (see Sections 10.1.1 and 4.3).

Molecular weight matrix
Water is the base ingredient of pet urine eliminator foam (Nature's Miracle, 2020). The molecular weight matrix is therefore set to the molecular weight of water, which is 18 g/mol. The Q-factor is set to 4.

Product amount – inhalation
The default product amount that is available for inhalation is set to 50 g. The stain needs to be saturated with the foam product (Nature's Miracle, 2020). It is therefore assumed that the volume of foam needed to treat the stain is equal to the volume of the urine excreted by the dog, which is considered to be 50 ml (see Section 10.1.1). Since water is the base ingredient of the foam (see above), the density of the product is about 1g/ml, resulting in a product amount used of 50 ml × 1g/ml = 50 g. The Q-factor is set to 1, because the derivation of the default depends on expert judgement.

Room volume
The intended use of pet urine odour remover foam is not limited to a certain room in the home, because a dog may urinate anywhere. The default room volume is therefore based on an unspecified room according to the General Fact Sheet (Te Biesebeek et al., 2014), which is 20 m^3 with a Q-factor of 4.

Ventilation rate
The default ventilation rate is that of an unspecified room, which is 0.6 per hour according to the General Fact Sheet (Te Biesebeek et al., 2014) with a Q-factor of 3.

Mass transfer coefficient
A number of models that are able to estimate the mass transfer coefficient for a flat surface have been evaluated (Meesters et al., 2018). The evaluation shows that different models estimate the mass transfer coefficient at between 2 and 16 m/h depending on the type of model used, the diffusivity of the substance in the air, its molecular weight and the air flow over the surface. Therefore, a generic default value for the mass transfer coefficient of 10 m/h is proposed in the Cleaning Products Fact Sheet (Meesters et al., 2018). The default mass

transfer coefficient of 10 m/h is thus also used for urine odour remover foams with a Q-factor of 2, because the underlying data are generic.

Release area
The release area refers to the surface area of the urine stain, which is set in accordance with the Cleaning Products Fact Sheet (Meesters et al., 2018) to 0.1 m^2. The Q-factor is set to 1, because the default refers to a stain surface area that was originally based on expert judgement (in the first Cleaning Products Fact Sheet, Prud’homme de Lodder, 2006a).

Emission duration
The emission duration refers to the length of time the foam product is left to soak into the stain. Product user instructions (UrineOff, 2020) indicate a duration of about 30 min. The default emission duration is thus set to 30 min. The Q-factor is set to 2, because the default is based on product information.

Exposed area
The exposed area refers to the top phalanges of five fingers of one hand (see Section 10.1.2), which is calculated to be 75 cm^2. The Q-factor is set to 3, because the underlying data described are of high quality but are lowered by the calculation described in Section 10.1.2.

Product amount – dermal
It is assumed that the amount of product per cm^2 applied to treat the stain is equal to the amount per cm^2 on the exposed skin area of the consumer. The exposed skin area is calculated as five fingertips, because the rest of the hand is protected by the cloth. The area of the stain that needs to be treated is considered to be 1000 cm^2 (Meesters et al., 2018), so an amount of product of 50 g/1000 cm^2 = 0.05 g/cm^2 is needed. The exposed skin area is considered to be 75 cm^2, referring to the area of five fingertips (see above). The default product subject to dermal exposure is thus calculated as 0.05 g/cm^2 × 75 cm^2 = 3.75 g. The Q-factor is 1 because of the crude assumption that the amount per cm^2 applied to the stain is equal to the amount per cm^2 on the exposed skin.

Table 10.3 Default values for estimating consumer exposure to substances in pet odour remover foam during urine treatment

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	See Section 10.1
Inhalation–exposure to vapour–evaporation–constant release area model			
Exposure duration	4 hours	2	Section 4.3
Molecular weight matrix	18 g/mol	4	Matrix is water
Product amount	50 g	1	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Application temperature	20 °C	4	Room temperature
Mass transfer coefficient	10 m/h	2	Meesters et al., 2018
Release area	0.1 m^2	1	Meesters et al., 2018
Emission duration	30 min	2	Product information
Dermal–direct product contact–instant application model			
Exposed area	75 cm^2	3	See this section
Product amount	3.75 g	1	See this section

10.3 Pet urine odour remover liquids

The default models and parameters used to estimate consumer exposure to substances in pet odour remover liquid are also used for pet urine odour remover foam, because both products are used for the same purpose of removing a pet urine stain; and both have water as the main ingredient of the product composition (Clorox, 2019; Nature's Miracle, 2020; UrineOff, 2020). The parameters referring to how the consumer uses the two products (product amount and emission duration) are therefore also considered to be similar, as are the parameters referring to the product matrix (i.e. molecular weight matrix). Furthermore, both products are used in the same scenario where a pet has left a urine stain in the home, and thus the frequency and location of exposure (unspecified room) are also the same (see Section 10.2). See Section 10.2 for further details of the models and parameters used.

Table 10.4 Default values for estimating consumer exposure to substances in pet odour remover liquid during urine treatment

Default value		Q-factor	Source(s)
General			
Frequency	52 per year	1	See Section 10.1
Inhalation–exposure to vapour–evaporation–constant release area model			
Exposure duration	4 hours	1	Section 4.3
Molecular weight matrix	18 g/mol	4	Matrix is water
Product amount	50 g	1	See this section
Room volume	20 m^3	4	Section 4.6.1
Ventilation rate	0.6 per hour	3	Section 4.6.1
Inhalation rate			
- adult users	0.55 m^3/h	3	Section 4.5.1
- infant bystanders	0.1 m^3/h	4	Section 4.5.2
Application temperature	20 °C	4	Room temperature
Mass transfer coefficient	10 m/h	1	Meesters et al., 2018
Release area	0.1 m^2	1	Meesters et al., 2018
Emission duration	30 min	2	Product information
Dermal–direct product contact–instant application model			
Exposed area	75 cm^2	3	See this section
Product amount	3.75 g	1	See this section

10.4 Pet odour sprays

Scenario for consumer exposure

Pet odour spray is used to cover bad odours left by pet hair, dander or sweat. The odour may persist after these are absorbed into fabrics such as carpets, sofas and mattresses. The consumer may choose to treat the unpleasant-smelling fabric by using a pet odour spray. The realistic conservative scenario is to assume that the odour spray is regularly used on a sofa, because it is a large fabric object where pets may lie regularly. A carpet is an even larger area, but it assumed that the consumer would not treat the entire carpet for pet odours. The way consumers handle pet odour spray to treat bad odours is considered to be similar to the way consumers use interior fabric freshener spray to treat furniture (see Section 9.2.4).

Therefore, the same default models and parameters used in interior fabric freshener spray are used to estimate consumer exposure to substances in pet odour sprays (9.2.4).

The ***inhalation–exposure to spray–spraying model*** is used to estimate inhalation exposure to non-volatile substances in pet odour spray. The ‘spraying towards person’ option is not considered relevant. Furthermore, the use of pet odour sprays is considered to be a general surface spraying activity, so that the option to ‘include oral ingestion of non-respirable material’ is not offered by default (4.1.4). The ***inhalation–exposure to spray–instantaneous release model*** is used to estimate inhalation exposure to the volatile substances in pet odour spray. The ***dermal–direct product contact–constant rate model*** is selected for the estimation of dermal exposure to droplets from the spray cloud depositing onto the skin of the consumer. For the default parameter values, see Section 9.2.4.

Frequency
Pet hair, dander or sweat left on a sofa are a reason to clean the sofa. The default frequency is therefore set to 52 per year as a conservative estimate. The Q-factor is set to 1, because the default is based on expert judgement.

Table 10.5 Default values for estimating consumer exposure to substances in pet odour sprays during the spraying of furniture (table continues on next page)

Default value		**Q-factor**	**Source(s)**
General			
Frequency	52 per year	1	See this section
Inhalation–exposure to spray–spraying model			
Spray duration[1]			
- *aerosol spray can*	11 s	1	See this section
- *pump spray*	100 s	1	See this section
- *trigger spray*	20 s	1	See this section
Exposure duration[2]	4 hours	1	Section 4.3
Room volume[2]	58 m^3	4	Te Biesebeek et al., 2014
Room height[1]	2.5 m	4	Te Biesebeek et al., 2014
Ventilation rate[2]	0.5 per hour	3	Te Biesebeek et al., 2014
Inhalation rate[2]			
- *adult users*	0.55 m^3/h	3	Section 4.5.1
- *infant bystanders*	0.1 m^3/h	4	Section 4.5.2
Mass generation rate[1]			
- *aerosol spray can*	0.5 g/s	2	Section 4.1.1.3
- *pump spray*	0.34 g/s	1	Section 4.1.1.4
- *trigger spray*	1.7 g/s	1	Section 4.1.1.5
Airborne fraction1			
- *aerosol spray can*	0.2	1	Section 4.1.1.3
- *pump spray*	0.02	2	Section 4.1.1.4
- *trigger spray*	0.018	1	Section 4.1.1.5
Density non-volatile[1]			
- *aerosol spray can*	1.1 g/cm^3	1	Section 4.1.1
- *pump spray*	1.13 g/cm^3	1	Section 4.1.1
- *trigger spray*	1.13 g/cm^3	1	Section 4.1.1
Inhalation cut-off diameter[1]	15 µm	3	Delmaar & Schuur, 2017
Aerosol diameter[1] median (CV)			
- *aerosol spray can*	76 µm (1.76)	1	Section 4.1.1.3
- *pump spray*	2.7 µm (0.73)	1	Section 4.1.1.4
- *trigger spray*	2.0 µm (0.39)	1	Section 4.1.1.5
Inhalation-exposure to spray-instantaneous release model			
Released mass[3]			Spray duration x mass generation rate
- *aerosol spray can*	5 g	1	
- *pump spray*	17 g	1	
- *trigger spray*	17 g	1	
Dermal–direct product contact-constant rate model			
Exposed area Contact rate	2200 cm^2	3	Section 4.1.3

Default value		Q-factor	Source(s)
- *aerosol spray can*	100 mg/min	2	Section 4.1.3
- *pump spray*	40 mg/min	1	Section 4.1.3
- *trigger spray*	46 mg/min	3	Section 4.1.3
Release duration			Twice the spray duration
- *aerosol spray can*	22 s	1	
- *pump spray*	200 s	1	
- *trigger spray*	40 s	1	

1: Applies to non-volatile substances only
2: Applies to both volatile and non-volatile substances
3: Applies to volatile substances only

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List of abbreviations

ACI	American Cleaning Institute
AISE	Association Internationale de la Savonnerie, de la Détergence et des Produits d'Entretien
ANSES	Agence Nationale de Sécurité Sanitaire de l'alimentation, de l'environnement et du travail
BfR	Bundesinstitut für Risikobewertung
BPR	Biocidal Products Regulation
CBS	Dutch Central Bureau for Statistics (Centraal Bureau voor de Statistiek)
CV	Coefficient of Variation
DEPA	Danish Environmental Protection Agency
EC	European Commission
ECHA	European Chemicals Agency
EPHECT	Emissions, Exposure Patterns and Health Effects of Consumer Products
FOPH	Federal Office of Public Health
HEAdhoc	Ad Hoc Working Group on Human Exposure to Biocides
HSL	Health and Safety Laboratory (United Kingdom)
KEMI	Swedish Chemical Agency
LICG	Dutch National Information Centre for Pets
Q-factor	Quality Factor
NIER	National Institute of Environmental Research (South Korea)
NVWA	Netherlands Food and Consumer Product Safety Authority (Nederlandse Voedsel- en Warenautoriteit)
OECD	Organisation for Economic Co-operation and Development
Q-factor	Quality factor
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RIVM	National Institute for Public Health and the Environment (Rijksinstituut voor Volksgezondheid en Milieu)
SCED	Standardised Consumer Exposure Determinant
SCP	Social Cultural Planning Bureau (Netherlands)
US-EPA	United States Environmental Protection Agency
VWS	Ministry of Health, Welfare and Sport (Netherlands)

Annex I. Refinement of inhalation exposure doses by applying a 'duration of stay' parameter

The inhalation exposure as described in the sections on electric plug-in evaporators (6.2), gel diffusers (6.9), capillary reed or wood diffusers (6.10) and potpourri (6.12) is a worst-case (first-tier) approach to calculating the inhaled dose. It assumes daily uninterrupted presence in the room concerned, ignoring the fact that consumers enter, remain in and leave a room following a pattern. Currently, ConsExpo Web software is not equipped with a model that accounts for the departure and re-entry of consumers. If the exposure assessor wishes to refine the calculation of the inhaled dose, guidance can be found here on how to do so, in this Fact Sheet. The ConsExpo Web model outcomes referred to as 'mean event concentration' acquired by using the default parameter values mentioned product section is need in this exercise.

The refinement includes a new parameter described here as *duration of stay*. The *duration of stay* refers to the average number of hours the consumer spends in the room per day.
The departure and re-entry patterns are included in the estimated inhalation exposure doses here as a way of refining the *inhalation external event dose* and the *external event dose on day of exposure*. The routines (presented below) refer to the equations to calculate inhalation doses from air concentrations as presented in the manual of ConsExpo Web (Delmaar & Schuur, 2018) extended with the term duration of stay*:*

$$\begin{aligned} re.entry\ inhalation\ external\ event\ dose \\ &= mean\ event\ concentration\ \times inhalation\ rate \\ &\times exposure\ duration \times \frac{duration\ of\ stay}{24\ hour} \end{aligned}$$

(Eq. 1)

and

$$\begin{aligned} re.entry\ inhalation\ external\ event\ dose\ on\ day\ of\ exposure \\ &= mean\ event\ concentration\ on\ day\ of\ exposure \\ &\times inhalation\ rate\ \times exposure\ duration \times \frac{duration\ of\ stay}{24\ hour} \end{aligned}$$

(Eq. 2)

The default *duration of stay* in a room for the consumer exposure scenarios mentioned in this annex is generically set to 4 hours. This 4-hour *duration of stay* refers to the leisure activities for which the consumer uninterruptedly stays in the same room of the home, as described in Section 4.3. It therefore refers mostly to the time a person spends using media, which, according to the Social Cultural Plan Agency (SCP), is at most 4 hours per day (SCP, 2019). The Q-factor is set to 1, because it is unclear to what extent the activity described as 'media use' actually represents the time the consumer stays in a room with an active air freshener product that is continuously releasing substances into the room air.

The *mean event concentration* and *mean event concentration on day of exposure* are delivered after performing a simulation with ConsExpo Web as described for electric plug-in evaporators, gel diffusers, capillary reed or wood diffusers and potpourri (Sections 6.2, 6.9, 6.10, 6.12). The *inhalation rate* and *exposure duration* are also presented as defaults in these sections, but it should be noted here that *exposure duration* needs to be expressed in units of hours in order to accurately apply the refinement routines above. Annex Table 1 presents an overview of the defaults per exposure scenario for the air freshener products described above.

Annex Table 1 Default values including duration of stay parameter as a refinement for the inhalation exposure doses of electric plug-in evaporators, gel diffusers, capillary reed or wood diffusers and potpourri

Air freshener products (section)	**Parameter**	**Value**	**Unit**
Electric plug-in evaporators (6.2.1)	Mean event concentration Mean event concentration on day of exposure Inhalation rate - *adult users* - *infant bystanders* Exposure duration Duration of stay	ConsExpo Web result ConsExpo Web result 0.55 0.1 1440 4	mg/m^3 mg/m^3 m^3/h m^3/h hours hours/day
Gel diffusers (6.9)	Mean event concentration Mean event concentration on day of exposure Inhalation rate - *adult users* - *infant bystanders* Exposure duration Duration of stay	ConsExpo Web result ConsExpo Web result 0.55 0.1 720 4	mg/m^3 mg/m^3 m^3/h m^3/h hours hours/day
Capillary reed or wood diffusers (6.10)	Mean event concentration Mean event concentration on day of exposure Inhalation rate - *adult users* - *infant bystanders* Exposure duration Duration of stay	ConsExpo Web result ConsExpo Web result 0.55 0.1 168 4	mg/m^3 mg/m^3 m^3/h m^3/h hours hours/day
Potpourri (6.12)	Mean event concentration Mean event concentration on day of exposure Inhalation rate - *adult users* - *infant bystanders* Exposure duration Duration of stay	ConsExpo Web result ConsExpo Web result 0.55 0.1 4380 4	mg/m^3 mg/m^3 m^3/h m^3/h hours hours/day

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