Existing Default Values and Recommendations for Exposure Assessment - A Nordic Exposure Group Project 2011

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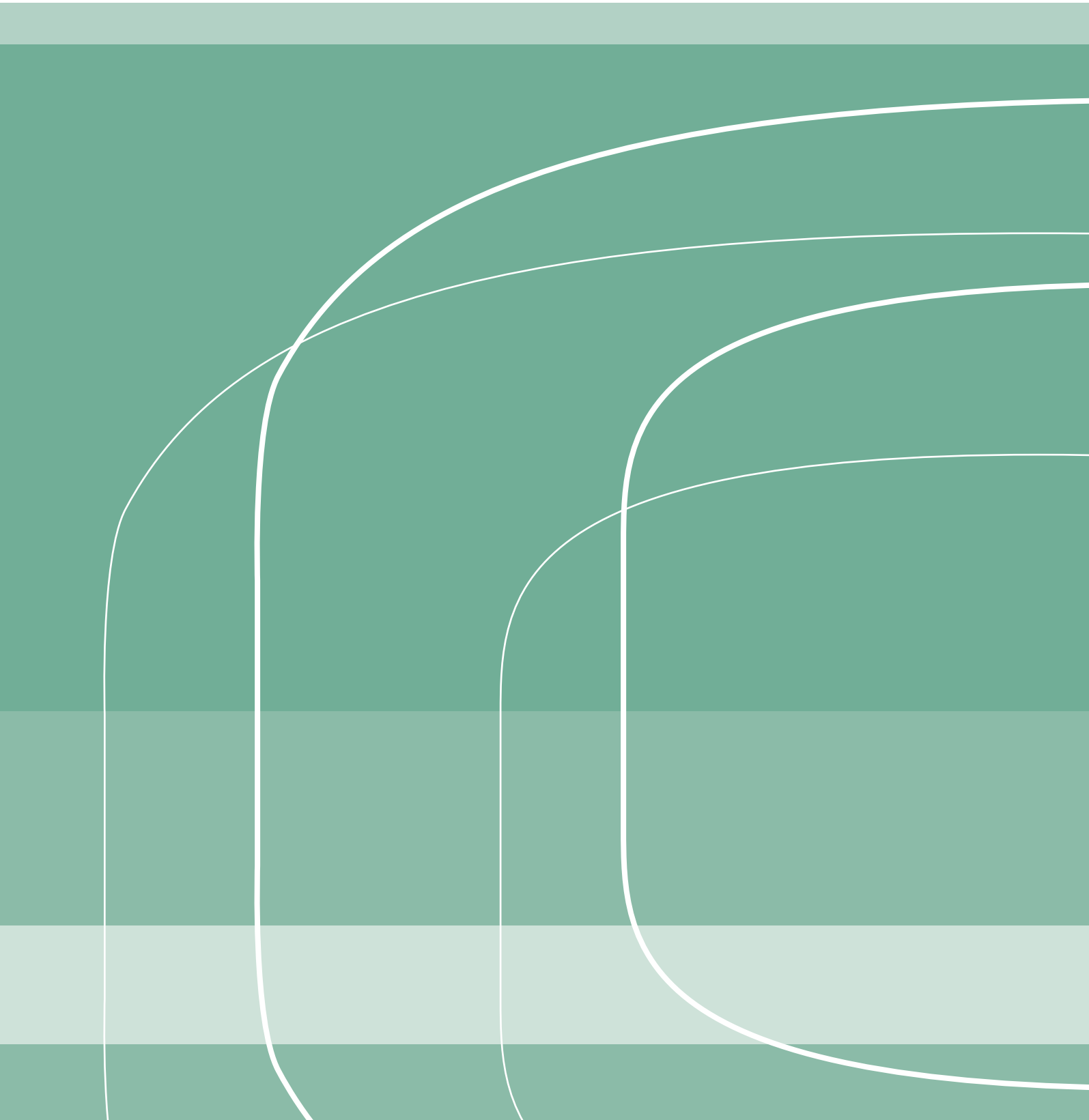


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Content

Abbreviations

AIHC	American Industrial Health Council
(C-)EFH	(Child-specific) Exposure Factors Handbook
CEFIC-LRI	European Chemical Industry Council, Long Range Research Initiative
CHAD	Consolidated Human Activity Database
CSFII	Continuing Survey of Food Intake among Individuals
D-EPA	The Danish Environmental Protection Agency
DIY	Do-it-yourself
ECETOC	European Centre for Ecotoxicology and Toxicology of Chemicals
ECHA	European Chemicals Agency
EFH	US-EPA Exposure Factors Handbook
EFSA	European Food Safety Authority
EUSES	European Union System for the Evaluation of Substances
ExpoFacts	European Exposure Factors database
GAF	General Assessment Factor
ICRP	The International Commission on Radiological Protection
IPCS	International Programme on Chemical Safety
IRIS	Integrated Risk Information System
METS	Metabolic equivalents
NHANES	The National Health and Nutrition Examination Survey
OECD	Organisation for Economic Co-operation and Development
REACH	Registration, evaluation, authorisation and restriction of chemicals
RfC	Reference Concentration
RfD	Reference Dose
RIVM	The National Institute for Public Health and Environment, Netherlands
SCOOP	Scientific Co-operation on Questions relating to Food
TGD	Technical Guidance Document
TNsG	The Technical Notes for Guidance
USDA	US Department of Agriculture
US-EPA	The United States Environmental Protection Agency
WHO	World Health Organization

Glossary

Absorbed fraction	The fraction of a substance which is absorbed following exposure
Activity factor	Factor used to characterise a given activity or time spent in a given activity
Airborne fraction	Fraction of non-volatile material that becomes airborne in the form of droplets
Applied dose	Amount of a substance at the absorption barrier (skin, lung, gastrointestinal tract) available for absorption
Cloud volume	The volume of a cloud of particles to which a person is exposed during spraying of a product
Coefficient of variation	Ratio of the standard deviation to the mean
Confidence rating	A qualitative rating of low, medium, or high to each recommended value in the US-EPA EFH.
ConsExpo	Computer software model for consumer exposure assessment
Contact rate	Rate at which a product is applied to the skin, in weight per time unit
Contact rate aerosol spray cans	The dermal contact rate during spraying of a product from an aerosol spray can
Contact rate trigger sprays	The dermal contact rate during spraying of a product from a trigger spray
Default value	Standard value
Default parameter value	Standard value for a specific parameter
Delivered dose	The amount of a substance transported to an individual organ, tissue or fluid of interest (the target)
Density	Measure of how much mass is contained in a given unit volume (density = mass/volume)
Dermal exposure	Direct exposure of / contact with the skin
Diffusion	One way of transport through a membrane
Dilution factor	Ratio of final volume/aliquot volume (final volume = aliquot + diluent)
Dislodgeable amount	Amount which can be removed
Effective (biologically) dose	Amount of a substance that actually reaches cells, sites or membranes
Emission Scenario Document	Document that describes the sources, production processes, pathways and use patterns with the aim of quantifying the emissions (or releases) of a substance into water, air, soil and/or solid waste
Estuarine fish	Fish living in a semi-enclosed body of water having a free connection with the open sea
Free-living	Opposite to staged activity measures
General Fact Sheet	Fact sheet containing the general information in relation to ConsExpo
Geometric mean	In mathematics, a type of mean or average, which indicates the central tendency or typical value of a set of numbers
Geophagy	Eating of soil

Hazard assessment	Effect assessment, i.e. assessment of possible adverse effects of a substance
Inhalation cut-off diameter	Measure for the diameter of spray droplets that can be inhaled and reach the lower areas of the lungs (alveoli, bronchioles, bronchia)
Inhalation exposure	Direct exposure of / contact with the respiratory tract
Initial droplet/particle distribution	The distribution of droplets/particles directly after spraying
Internal dose	Amount of a substance that has been absorbed and is available for interaction with the biologically target organs and tissues
Key study	In the US-EPA EFH, the most useful studies for deriving exposure factors
Leachable fraction	Relative amount of chemical which can leach from a product
Lognormal distribution	Probability distribution of a random variable whose logarithm is normally distributed
Lognormal body weight distribution	Probability distribution of body weight variables whose logarithm are normally distributed
Mass generation rate	Mean mass generation rate during the entire duration of spraying calculated from the sprayed amount and the total duration of spraying
Molecular Weight Matrix	Parameter used to calculate the relative vapour pressure of a component
Mouthing times	Duration of an object kept in the mouth
Neonatal weight	Body weight of a new-born infant
Oral exposure	Direct exposure of / contact with the gastro-intestinal tract
Per capita	Per person
Physiologic information	Information on physiological parameters
Pica	Deliberate ingestion of larger amounts of non-nutritive substances
Planimeter	Measuring instrument used to determine the area of an arbitrary two-dimensional shape
Pneumatic	Mechanism activated, controlled, or powered by air or gas pressure
Postpartum	Period just after delivery
Potential dose	Amount of a substance contained in material ingested, inhaled or in material applied to the skin
Product amount	Amount of a product used in a specific use scenario
Recreational marine intake	Consumption of marine fish catch as part of a sporting or recreational activity and not for the purpose of providing a primary source of food
Relevant study	In the US-EPA EFH, studies that are applicable or pertinent, but not necessarily the most important to derive exposure factors
Spray duration	Duration of spraying
Total duration	Entire duration of an activity
Transfer coefficient	The “transfer coefficient” is a quantification of the transfer of powder from the carpet surface to human skin per unit time as e.g. a child is crawling across a treated carpet, wiping some of the powder
Use duration	Duration related to the use of a product
Weight fraction	Weight fraction of a solution/dilution is the weight fraction of the product divided by the dilution factor

Foreword

The project was funded by the Nordic Council of Ministries through the Nordic Chemicals Group. The project was launched and coordinated by the Nordic Exposure Group, which also act as a project steering group. The practical work was done two consultants from Division of Toxicology and Risk Assessment National Food Institute, Technical University of Denmark

The draft version of the report was presented in the Nordic Workshop, on 3th–4th of May 2011 in Oslo. The report was finalised based on the major comments from the WS participants.

The members of the steering group and consultants are introduced below:

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Consultants

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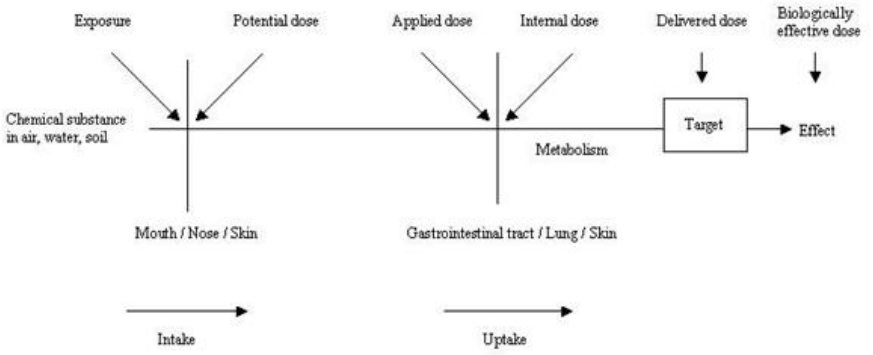
1. Introduction

The International Programme on Chemical Safety (IPCS) has defined exposure as the "contact of an organism with a chemical or physical agent, quantified as the amount of chemical available at the exchange boundaries of the organism and available for absorption." (WHO/IPCS, 2001). This means contact with the visible exterior of a person such as the skin, and openings such as the mouth, nostrils, and lesions.

The process of a chemical entering the body can be described in two steps: Contact (exposure) followed by entry (crossing the boundary, i.e., absorption). The process begins with a chemical being released from a source into the environment. Once in the environment, the chemical can be transformed and transported through the environment via air, water, soil, dust, and food. Individuals become in contact with the chemical in the environment through inhalation, ingestion, or skin/eye contact. Individuals may also come in contact with chemicals in consumer products as well as during work. The individual's activity patterns as well as the concentration of the chemical will determine the magnitude, frequency, and duration of the exposure. The exposure becomes an absorbed dose when the chemical crosses an absorption barrier (entry into the body). When the chemical or its metabolites interact with a target tissue, it becomes a target tissue dose, which may lead to an adverse health outcome, the biologically effective dose. Figure 1 illustrates the relationship between exposure and different types of dose.

Figure 1. Correlation between exposure concentration and internal dose. Modified from US-EPA (1997)



The applied dose is the amount of a substance at the absorption barrier (skin, lung, gastrointestinal tract) available for absorption. Usually it is very difficult to measure the applied dose directly at the absorption barrier. An approximation of the applied dose can be made using the poten-

tial dose, which is the amount of the substance ingested, inhaled or in material applied to the skin. The applied dose, or the amount that reaches the exchange boundaries of the skin, lung or gastrointestinal tract, may often be less than the potential dose if the substance is only partly bioavailable. The amount of a substance that has been absorbed and is available for interaction with the biologically target organs and tissues is called the internal dose. The amount transported to an individual organ, tissue or fluid of interest (the target) is termed the delivered dose (or target tissue dose); the delivered dose may be only a part of the total internal dose. The biologically effective dose, or the amount that actually reaches cells, sites or membranes where adverse effects occur, may only be a part of the delivered dose. Doses are often presented as dose rates, or the amount of a chemical dose (applied or internal) per unit time (e.g., mg/day), or per-unit-body-weight-basis (e.g., mg/kg body weight per day). (WHO/IPCS, 1999).

According to the REACH "Guidance on Information Requirements and Chemical Safety Assessment" published by the European Chemicals Agency (ECHA) (ECHA, 2010), "exposure to a particular substance should normally be understood as meaning external exposure. This can be defined as the amount of the substance ingested, the amount in contact with the skin, and/or the amount inhaled (which is represented by the airborne concentration of the substance in the breathing zone). It does not usually refer to concentrations within the body, which are determined by the amount of the substance absorbed from the digestive system, respiratory system, or entering the body through the skin." Exposure can be considered as a single event, as a series of repeated events or as continuous exposure.

The aim of an exposure assessment is to determine the nature and extent of contact with chemical substances experienced or anticipated under different conditions. An exposure assessment is the quantitative or qualitative evaluation of the amount of a substance that humans come into contact with and includes consideration of the intensity, frequency and duration of contact, the route of exposure (e.g., dermal, oral or respiratory), rates (chemical intake or uptake rates), the resulting amount that actually crosses the boundary (a dose), and the amount absorbed (internal dose). Depending on the purpose of an exposure assessment, the numerical output may be an estimate of the intensity, rate, duration and frequency of contact exposure or dose (the resulting amount that actually crosses the boundary). (WHO/IPCS, 1999).

Exposure data can be either measured or calculated. Measured exposure data are preferred, if they are valid. Often measured exposure data are not available, or they are not considered valid, and therefore model-generated data must be used. An exposure model is "*a conceptual or mathematical representation of the exposure process*" (WHO/IPCS, 2004); i.e., a tool to calculate an estimate (a figure) to use in the risk characterisation, e.g., where the outcome of the hazard assessment is compared with

an exposure estimate. The output of an exposure model can be an exposure concentration; in practice, however, exposure often includes estimates of intake (e.g., amount of chemical inhaled or ingested) and the amount of a chemical that is absorbed into the body (e.g., amount of chemical that penetrates the skin or the lining of the lung) (WHO/IPCS, 2005). Exposure models can be developed to estimate exposures and doses of individuals, defined population groups, or entire populations. Exposure may be estimated as a continuous variable or integrated over time ranging from minutes to a lifetime. The modelled outputs may include mean or median values, distribution parameters (standard deviations, quartiles, ranges), or entire distributions. Consequently, exposure models vary widely in complexity, approach, inputs, and outputs (WHO/IPCS, 2005).

In order to perform an exposure assessment, it is necessary to apply various "non-chemical-specific" exposure related parameters such as e.g., body weight, body surface area, activity factors, ventilation rates, ingestion of water/food etc. These parameters are called non-chemical-specific exposure factors and are generally drawn from the scientific literature or governmental statistics.

The approach to exposure assessment is not as internationally harmonised as hazard assessment. Although broad consistency in the overall approaches used by different bodies and countries in conducting exposure assessment exists, there is variation in the types of approaches and tools used, including the use of exposure factors.

The purpose of this report is to give an overview of non-chemical-specific exposure factors to be used by the authorities during the process of assessing exposure to both adults and children as well as of risk assessment in relation to REACH, and to contribute towards a further harmonisation of such exposure factors to be used in exposure assessments. Thus, the process of exposure assessment in itself is not further addressed in this report. . The percentile chosen is a decision that has to be made by the assessor depending on the purpose of the assessment. For transparency, the reasoning for the choice of values should always be available in the assessment report.

The following non-chemical-specific exposure factors are addressed in this report:

- Body weight
- Body surface areas
- Inhalation rates
- Ingestion of drinking water
- Intake of food
- Ingestion of soil and dust
- Non-dietary ingestion factors
- Lifetime expectancy
- Activity factors
- Consumer products

In the following, guidance and recommendations provided by various EU bodies, with the main focus on the information gathered in the REACH "Guidance on Information Requirements and Chemical Safety Assessment" (REACH GD IR&CSA) published by the European Chemicals Agency (ECHA) (ECHA, 2010), will be addressed first as this report is directed primarily towards the exposure factors to be used in exposure assessments in the context of the EU chemical regulation "REACH". Then the US guidance and recommendations will be addressed using US-EPA Exposure Factor Handbook, at the time (December 2010) available in the form of an external review draft (US-EPA, 2009), which provides the most comprehensive overview and data basis, considerations, evaluations and recommendations in the area of non-chemical-specific exposure factors. The revised Exposure Factor Handbook was published in September 2011, after the finalisation of the work in this Nordic report. Finally, guidance and recommendations provided by the WHO will be addressed as this report also is meant to contribute towards a further harmonisation of exposure factors to be used in exposure assessments.

Below, the main EU, US and WHO sources of non-chemical-specific exposure factors will be addressed. The OECD has not published any guidance or recommendations on the use of non-chemical-specific exposure factors.

1.1 Europe

1.1.1 ECHA

The European Chemicals Agency (ECHA) under REACH has published a "*Guidance on Information Requirements and Chemical Safety Assessment*" (REACH TGD) that describes the information requirements under REACH with regard to substance properties, exposure, use and risk management measures, and the chemical safety assessment (ECHA, 2010). It is part of a series of guidance documents that are aimed to help all stakeholders with their preparation for fulfilling their obligations under the REACH regulation. These documents cover detailed guidance for a range of essential REACH processes as well as for some specific scientific and/or technical methods that industry or authorities need to make use of under REACH.

Part D of the REACH TGD details how to develop exposure scenarios and related exposure estimation. Part D provides also links to more in-depth guidance on exposure assessment. This includes: Occupational exposure estimation (Chapter R.14), exposure estimation related to consumers (Chapter R.15), and exposure estimation related to the environment (Chapter R.16). Recommendations on exposure factors are generally limited although Chapter R.15 provides some information regarding default values for exposure factors to be used for consumer exposure

assessment, such as amount of product used per application and exposure time. These recommendations are generally obtained from the RIVM (The National Institute for Public Health and the Environment, Netherlands) fact sheets for specific products, in order to build consistency with ConsExpo, a well-known computer tool for consumer exposure assessment (see Section 1.1.2). Chapter R.16 provides some information regarding default values to be used for exposure factors related to the environment, such as human intake rates of crops, meat and fish, dairy products and drinking water; these default values are used in EUSES, the computer tool used for exposure assessment related to the environment (see Section 1.1.3).

Chapter R8, Table R. 8–18, of the REACH TGD *"Characterisation of dose [concentration]-response for human health"* (ECHA, 2008a) also provides some information regarding default values for exposure factors to be used for exposure assessments of consumers and man exposed indirectly via the environment as well as for exposure assessments of workers. It should be noted that the recommendations in Table R.8–18 are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommendations are taken from one of these references or both. The reference "ICRP, 1975" is to the International Commission on Radiological Protection (ICRP) Publication No. 23 *"Report of the Task Group on Reference Man"*, which was adopted in October 1974 and published in April 1975. It should be noted that other bodies, e.g., WHO (WHO/IPCS, 1994 and 1999) refer to this ICRP report as "ICRP, 1974."

1.1.2 ConsExpo

The National Institute for Public Health and the Environment, Netherlands (RIVM) is a Dutch research institute that is an independent agency of the Dutch Ministry of Health, Welfare and Sport. In order to mathematically predict human exposure to consumer products, RIVM has developed the software model ConsExpo (RIVM, 2010). ConsExpo, which can be downloaded from the internet (the link can be find in the reference list, reference "RIVM, 2010"), is a set of coherent, general models that enables the estimation and assessment of the exposure to substances from consumer products and their uptake by humans. ConsExpo models and ConsExpo data can be used, where appropriate, in order to assess also professional exposure. The assessor should though take the differences between professional and non-professional uses (e.g. use period, use frequency or use of PPEs) into consideration (HEEG (Human Exposure Expert Group) opinion, endorsed on the second Technical Meeting on Biocides 2008). Data about the application of products and data from mathematical models are used to build up the program. The program is based on relatively simple exposure and uptake models. The starting point for these models is the route of exposure, i.e. the inhalation, dermal or oral route. The most appropriate exposure scenario and

uptake model is chosen for each route. The parameters needed for the exposure scenario and the uptake models are then filled in. It is possible that exposure and uptake occur simultaneously via different routes. In addition to data about the exposure and uptake, general scenario data is also needed, such as the frequency and body weight of the exposed person. Using the data mentioned above, ConsExpo calculates the exposure and uptake. For this purpose fact sheets are developed.

The fact sheets give information that is important for the consistent estimation and assessment of the exposure to, and the uptake of, substances from consumer products, such as paint, do-it-yourself products, cosmetics and cleaning products. In the fact sheets, information about exposure to chemical substances is bundled into certain product or exposure categories. These categories are chosen so that products with similar exposures can be combined. On the one hand, the fact sheet gives general background information, while on the other hand, it quantifies exposure parameters which, together with an exposure scenario, or a combination of the various exposure scenarios, produces a quantitative estimate of the exposure. (RIVM, 2010).

In the *General Fact Sheet*, (RIVM, 2006a) general information is presented that is needed for consumer exposure assessment in addition to the more specific information provided in the fact sheets on the different product groups. Information includes: The volume and surface area of rooms in Dutch dwellings, the air-change rate in various rooms in dwellings and the total body surface and surface of body parts of adults and children. Also, general information on the fact sheets is given, such as a description the format of the fact sheets, the connection with the ConsExpo program and the boundary conditions under which the defaults in the fact sheet are defined.

In addition to the *General Fact Sheet*, fact sheets are available for children's toys (RIVM, 2002), cleaning products (RIVM, 2006c), cosmetics (RIVM, 2006b), disinfectants (RIVM, 2006d), “do-it-yourself products” (RIVM, 2007a), paints products (RIVM, 2007b) and pest control products (RIVM, 2006e).

In the *Exposure to chemicals via house dust*, (RIVM, 2008), the potential of house dust being a health risk is investigated and in this connection, exposure to dust via ingestion and inhalation have been examined.

The consumer exposure estimation should normally address the intended uses of the products that contain the substances under investigation. However, since consumers may not accurately follow instructions for use of products, an estimation of other reasonably anticipated uses should be made (ECHA, 2008b).

In the fact sheets provided by the RIVM, the basis for the calculation and/or estimation of the default parameter values is a realistic worst-case scenario, and considers consumers who frequently use a certain product under relatively less favourable circumstances. For example, when using a cosmetic product, basic assumptions are: relatively fre-

quent use, application of a relatively large amount in a small room with a low ventilation rate, and a relatively long stay in that room. The parameter values in the fact sheets are aimed at (Dutch) consumers. They are chosen such that a relatively high exposure and uptake are calculated, in the order of magnitude of a 99th percentile of the distribution. To achieve this goal, the 75th or the 25th percentile is calculated (or estimated) for each parameter. The 75th percentile is used for parameters which give a higher exposure for higher values, and the 25th percentile is used in the reverse case (RIVM, 2006a).

1.1.3 EUSES

The European Union System for the Evaluation of Substances (EUSES) is a decision-support instrument, which enables government authorities, research institutes and chemical companies to carry out rapid and efficient exposure assessments for chemical substances (ECB, 2010).

Indirect exposure of humans via the environment may occur by consumption of food (fish, crops, meat and milk) and drinking water, inhalation of ambient air, and ingestion of soil. For existing substance, measured levels in various environmental compartments may be available; however, for new substances, usually no relevant measured data are available and concentrations of a substance in the environment must be estimated.

The indirect exposure is estimated by the use of EUSES. EUSES estimates concentrations in food and the total daily intake of a substance based on predicted environmental concentrations for (surface) water, groundwater, soil, sediment and ambient air. The indirect exposure is principally assessed on two spatial scales: locally near a point source of the substance, and regionally using averaged concentrations over a larger area. A third spatial scale, the continental scale, is also assessed by EUSES; however, this scale is not included in the estimations of the indirect exposure.

EUSES is intended mainly for the initial (screening) and intermediate (refined) stages of exposure assessments rather than comprehensive assessments. On the basis of the screening, it can be decided whether more data need to be generated and whether a more refined assessment is necessary. EUSES can also be applied for refined assessments by allowing the replacement of default values, estimated parameter values, or intermediate results by more accurately estimated values or by measured data. EUSES is not specifically designed for site-specific assessments (defaults represent a standard region in EU), but adjustment of parameters may allow for insight into specific local or regional situations.

The system is fully described in the extensive EUSES documentation and is based on the EU Technical Guidance Documents (TGD) on Risk Assessment for New Notified Substances, Existing Substances and Biocides (EC, 2003). The new EUSES 2.1 version (2008) is an update of EUSES 2.0, containing all Emission Scenario Documents for biocides. The

development of EUSES 2.1 was commissioned by the European Commission to the National Institute of Public Health and the Environment (RIVM) of The Netherlands. The documentation and the program can be downloaded (free of charge) from the Ex-ECB Website (ECB, 2010).

1.1.4 TNsG

According to the Biocidal Products Directive, a risk assessment of biocidal products is required before these can be placed on the European Market. The estimation of human exposure is fundamental for the risk assessment and requires quantification of the levels of exposure for both users of the biocidal product and others who may be exposed following its use. As there is still a paucity of exposure data on biocides, various approaches are used to estimate human exposure to them. From 1998 onwards the European Union funded a series of projects to both fill this knowledge gap and establish a harmonised approach for assessing human exposure to biocides. The outcome of these projects was the publication of the *Technical Notes for Guidance on Human Exposure to Biocidal Products* (TNsG). (TNsG, 2007).

The most recent version of the TNsG (TNsG, 2007) covers all product types and presents worked examples for each of them. This TNsG consists of a written part, as well as a computerised database (BEAT) of exposure data (largely for occupational settings), and the consumer exposure model ConsExpo. The worked examples are indicated in the written part and are described in detail in the database.

1.1.5 ExpoFacts

In 2002, the European Exposure Factors (ExpoFacts) database started as a two-year project funded by CEFIC-LRI (European Chemical Industry Council, Long Range Research Initiative) to create a European database of factors affecting exposure to environmental contaminants. The aim was to create a public access data source, similar to the US-EPA *Exposure Factors Handbook*, 1997, which has been widely used by European researchers, but with European data. Since 2007, the project is hosted by the European Commission's Joint Research Centre. (JRC, 2010).

When the project was started in 2002, European exposure factor data were scattered within numerous national and international institutions. The ExpoFacts database has created no new data, but instead compiled the existing data into one Internet database, where it can be easily found, screened and downloaded from. Data were collected from the EU

countries, candidate countries to EU, and EFTA[1] countries. As a result, the ExpoFacts database contains data from 30 European countries. In addition to the population time use patterns and exposure route information, e.g., dietary statistics, the database contains socio-demographic and physiologic information to enable database use as a tool for population-wide exposure modelling and risk assessment. (JRC, 2010).

The methodological information, which is provided in the ECETOC sourcebook (ECETOC, 2001), is not found in the ExpoFacts database. Therefore, the ExpoFacts database can not replace the ECETOC sourcebook, but adds new information and Internet accessibility. (JRC, 2010).

As the ExpoFacts database has compiled the existing data, but created no new data, this database has not been used as a primary source for exposure factors in this report.

1.1.6 ECETOC Sourcebook

ECETOC (European Centre for Ecotoxicology and Toxicology of Chemicals) has published a report with European exposure factors titled "*Exposure Factors Sourcebook for European Populations, with Focus on UK Data*" (ECETOC, 2001). This document was the first broader compilation of European exposure factors and contains methodological information. The ECETOC sourcebook updates and builds upon other collections of exposure factor data including the 1994 *American Industrial Health Council's Exposure Factors Sourcebook* (AIHC) and the US-EPA *Exposure Factors Handbook* (US-EPA, 1997); the AIHC no longer exists. The information in the ECETOC sourcebook includes physiological parameters (body weight, body surface areas, life expectancy), time-activity patterns (work hours, indoor/outdoor time, etc.), and receptor contact rates (soil ingestion rates, food consumption rates, etc.). The ECETOC sourcebook is not publicly available.

1.1.7 Other

In addition to the above-mentioned sources of exposure factors, there are a number of other sources. These sources will not be described here but will appear in the following sections when appropriate.

[1] European Free Trade Association, presently comprising Iceland, Liechtenstein, Norway and Switzerland. European countries, that are not EU member states, can cooperate with EU via EFTA.

1.2 The United States

The US-EPA Exposure Factors Handbook (EFH) (US-EPA, 2009) has been prepared to provide information and recommendations on various factors used in assessing exposure to both adults and children. The handbook provides non-chemical-specific data on a number of physiological and behavioural exposure factors such as e.g., body weight, dermal factors, life time, activity factors, inhalation rates, ingestion of water, food items and soil/dust, consumer products.

The EFH was first published in 1989, revised in 1997, and then in 2009. The 2009 version is currently (October 2010) available in the form of an external review draft (US-EPA, 2009). Recognizing that exposures among infants, toddlers, adolescents, and teenagers can vary significantly, the US-EPA published the Child-Specific Exposure Factors Handbook (C-EFH) in 2002 and its revision in 2008 (US-EPA, 2008). The 2009 version of the EFH incorporates new factors and data provided in the 2008 version of the C-EFH as well as other relevant information published through June 2009.

In order to promote scientific consensus on risk assessment issues, US-EPA has developed the Guidance for Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (US-EPA, 2005). This guidance document recommends a set of age groupings based on current understanding of differences in life stage behaviour and anatomy and physiology that can serve as a starting set for consideration by risk assessors and researchers. The 2008 version of the C-EFH as well as the 2009 version of the EFH reflect the age categories recommended in this guidance document: Birth to <1 month, 1 to <3 months, 3 to <6 months, 6 to <12 months, 1 to <2 years, 2 to <3 years, 3 to <6 years, 6 to <11 years, 11 to <16 years, 16 to <21 years. Adult data (i.e., for individuals >21 years old), on the other hand, are presented using the age groups defined by the authors of the individual studies.

The US-EPA Consolidated Human Activity Database (CHAD) (US-EPA, 2007a) contains data obtained from pre-existing human activity studies that were collected at city, state, and national levels. CHAD is intended to be an input file for exposure/intake dose modelling and/or statistical analysis. CHAD is a master database providing access to other human activity databases using a consistent format. This facilitates access and retrieval of activity/and questionnaire information from those databases that US-EPA currently has access to and uses in its various regulatory analyses undertaken by program offices. CHAD provides no recommendations on human activity, but their data are used in order to calculate recommendations by other studies cited in this report.

The data presented in the EFH (US-EPA, 2009) have been compiled from various sources, including government reports and information presented in the scientific literature. The studies presented in the EFH were chosen because they were considered by the US-EPA as being use-

ful and appropriate for recommending exposure factors. When evaluating the scientific and technical information, the US-EPA has applied five so-called "general assessment factors" (GAFs):

- Soundness (adequacy of approach and minimal or defined bias)
- Applicability and utility (focus on the exposure factor of interest, representativeness of the population, currency of the information, and adequacy of the data collection period)
- Clarity and completeness (accessibility, reproducibility, and quality assurance)
- Variability and uncertainty (variability in the population and uncertainty in the results)
- Evaluation and review (level of peer review and number and agreement of studies)

These GAFs were adapted and expanded to include specific considerations deemed to be important during evaluation of exposure factors data, and were used to judge the quality of the underlying data used to derive recommendations.

The studies included in the EFH (US-EPA, 2009) were designated as "key studies" or "relevant studies." Key studies were generally defined as the most useful for deriving recommendations for exposure factors. The recommended values for most exposure factors in the EFH are based on the results of such key studies. Other studies were designated as "relevant studies" meaning that they provided applicable or pertinent data, but not necessarily the most important ones for a variety of reasons (e.g., data were outdated, limitations in study design). The distinction between key and relevant studies was on the GAFs. This report include predominantly the studies designated as "key studies" and only a few of the studies designated as "relevant studies" have been selected for inclusion.

The US-EPA (US-EPA, 2009) has assigned a confidence rating of low, medium, or high to each recommended value (US-EPA, 2009). It has been underscored that this qualitative rating was not intended to represent uncertainty analyses but to represent the US-EPA's judgment on the quality of the underlying data used to derive the recommendations. The judgment was made using the GAFs. It is noted that there is a continuum from low to high, and that judgment was used to assign a rating to each factor. The recommendations given in the EFH (US-EPA, 2009) are accompanied by a discussion of the rationale for their rating.

In the providing of recommendations for the various exposure factors, the US-EPA has made an attempt to present percentile values that are consistent with the exposure estimators defined in Guidelines for Exposure Assessment (US-EPA, 1992), i.e., mean and upper percentile (US-EPA, 2009). It is noted that this was, however, not always possible, because the available data were limited for some exposure factors, or the authors of the study did not provide such information. In the EFH

(US-EPA, 2009), the term "upper percentile" is intended to represent values in the upper tail, i.e., between 90th and 99.9th percentile of the distribution of values for a particular exposure factor.

Finally, it is underscored that the recommendations provided in the EFH (US-EPA, 2009) should be interpreted as suggestions that exposure/risk assessors can consider and modify as needed based on their own evaluation of a given risk-assessment situation.

1.3 WHO

The WHO/IPCS has undertaken a project to harmonize approaches to the assessment of risk from exposure to chemicals through increased understanding. The project focuses on specific issues and attempts to achieve agreement on basic principles. Among the project's focus areas are exposure assessment and terminology for exposure assessment and risk assessment. The status for the activities of the harmonization project is published in a newsletter. (WHO/IPCS, 2010).

Under this project, an IPCS Harmonization Project Document on the Principles of Characterizing and Applying Human Exposure (WHO/IPCS, 2005) and an IPCS Harmonization Project Document on Characterizing and Communicating Uncertainty in Exposure Assessment (WHO/IPCS, 2008) have been published. None of these documents contain specific recommendations on default values for human exposure factors.

The WHO recommendations on exposure factors included in this report stem mainly from data published by the International Commission on Radiological Protection (ICRP, 1974). These recommendations are to be found in reports which are produced in cooperation with the IPCS, namely the Environmental Health Criteria 170 and 210 (WHO/IPCS, 1994 and 1999 respectively). The reference "ICRP, 1974" is to the ICRP Publication No. 23 *"Report of the Task Group on Reference Man"*, which was adopted in October 1974 and published in April 1975. It should be noted that ECHA, in the REACH TGD (ECHA, 2010), refers to this ICRP report as "ICRP, 1975".

The WHO/IPCS Environmental Health Criteria 214 (WHO/IPCS, 2000) addresses human exposure assessment in general and a section on exposure factors are included; however, no recommendations on specific values are provided in this document.

2. Body Weight

The average daily dose is a dose that is typically normalized to the average body weight of the exposed population. If exposure occurs only during childhood years, the average child body weight during the exposure period should be used to estimate risk. Conversely, if adult exposures are being evaluated, an adult body weight value should be used. (US-EPA, 2009).

2.1 Europe

In the *REACH Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a), a body weight of 70 kg (men and women combined) is recommended for exposure assessments of consumers and man exposed indirectly via the environment as well as for workers (Table R. 8–18).

In the REACH *Guidance on information requirements and chemical safety assessment Chapter R15: Consumer exposure estimation* (ECHA, 2008b), it is stated that default body weights of 70 kg for adult males and 60 kg for adult females may in principle be used. For further analyses, particularly for estimations of children's exposure, it is stated that more detailed compilations of body weights (including distributions) are available for Germany (AUH, 1995), The Netherlands (Bremmer et al., 2006; please note that this reference is to the ConsExpo General Fact Sheet RIVM, 2006a), as well as for the US (e.g., US-EPA, 1997), but no further recommendations are provided.

In the Preparation of a Guidance Document on Pesticide Exposure; Assessment for Workers, Operators, Bystanders and Residents (EFSA, 2010), it is proposed that the body weight of an adult should be taken as 60 kg, and those for children aged 10 to <12 months, 1 to <3 years, 3 to <6 years, 6 to <11 years, and 11 to <16 years, as 8.7, 12.3, 17.5, 28.7 and 50.2 kg respectively. EFSA has cited ECETOC (2001) as the reference, see below. On request from EFSA the Scientific Committee has recently developed a guidance document on harmonisation of default values used by EFSA's Scientific Panels, Committees and Units (Draft guidance on Default assumptions 2011). The Scientific Committee recommends a body weight of 70 kg as default for European adults. For dietary exposure assessment, a body weight of 12 kg should be used as default for European infants and children. If deviation from the default value is required for the assessment of specific age groups, the median values identified in Table 2.1 should be used.

According to the Report from the Commission on Dietary Food Additive Intake in the European Union, Commission of the European Communities (2001), the default value for young children (under three years), which is 15 kg of body weight and the default value for adults, which is 60 kg, should be used when reporting monitored data. This report is the outcome of the SCOOP Task 4.2 on "Methodologies for monitoring of food additive intakes."

RIVM has calculated default values on body weight for children of various age groups, presented in Annex B, Tables B.2 and B.3. For adult men, a body weight of 74 kg is recommended and for adult women a weight of 61 kg is recommended. For both men and women, RIVM has provided a default value of 65 kg. (RIVM, 2006a).

The Danish Environmental Protection Agency (D-EPA) has in their *Guidance from the Environmental Protection Agency No. 5* (D-EPA, 2006) recommended a default value of 13 kg for children aged one to three years, and a default value of 70 kg for adults (D-EPA, 2006).

Table 2.1 presents a summary of body weights recommended by different European bodies.

Table 2.1: Default Values on Body Weights Recommended by Various European Bodies

	Body Weight (kg)
EFSA	
0–3 months	4.8
3–6 months	6.7
6–12 months	8.7
1–3 years	11.6
3–10 years	21.6
10–14 years	42.0
3–<6 years	17.5
14–18 years	60.0 (both sexes combined), 65 (boys) / 56 (girls)
Adults	70
Commission of the European Communities (SCOOP data)	
0–<3 years	15
Adults	60
ECHA	
Adults	70 (both sexes combined), 70 (men) / 60 (women)
RIVM	
1.5 months	4.30
4.5 months	6.21
7.5 months	7.62
10.5 months	8.69
13.5 months	9.47
1.5 year	9.85
2.5 years	12.5
3.5 years	14.1
4.5 years	16.3
6.5 years	20.6
9.5 years	28.4
12.5 years	39.3
13.5 years	43.9
17.5 years	58.2
Men	74
Women	61
Adults	65

Sources: EFSA (2011), Commission of the European Communities (2001), ECHA (2008a and 2008b) and RIVM (2006a)

According to the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), the recommended mean body weight for English adults aged 16 and older is 73.2 kg. In Table 2.2, age and gender specific distributions of English adults are presented from data based on anthropometric measures. In Annex A, Table A.1, country specific estimates of adult (over 20 years of age) body weight are presented; the mean weights are based upon nationally representative data sets for about half of the countries listed, extrapolated to year 2000 based upon analysis of recent trends in body mass. For countries with no data, the WHO (which is the source of these data) used values from countries considered to be appropriate proxies (ECETOC, 2001).

Table 2.2: Recommended Values for Adult Body Weight – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Age (years)	Men			Women		
	Mean (kg)	5th (kg)	95th (kg)	Mean (kg)	5th (kg)	95th (kg)
16–24	72.8	54.5	97.1	62.7	47.8	85.9
25–34	80.7	60.9	105.6	67.0	50.0	91.3
35–44	82.4	63.1	107.6	67.8	50.4	93.7
45–54	82.7	62.3	106.5	69.3	50.9	94.3
55–64	82.8	63.4	107.3	70.7	52.0	95.0
65–74	78.9	60.0	100.5	68.2	48.2	92.0
75+	74.1	56.6	94.1	63.4	44.4	83.3
≥16	80.0	60.1	104.2	67.3	49.3	91.7

Source: UK Office for National Statistics, 1998; modified from ECETOC, 2001

Table 2.3 presents mean body weight for children aged 2–15 years in England from the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001). The data are derived from the 1995–1997 Health Surveys for England. All data where measured during the survey and the recommended mean body weight is 33 kg. For children younger than 2 years, ECETOC refers to the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997).

Table 2.3: Recommended Values for Child Body Weight – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Age (years)	Males			Females		
	Mean (kg)	5th (kg)	95th (kg)	Mean (kg)	5th (kg)	95th (kg)
2	14.2	11.6	17.5	13.7	11.2	16.7
3	16.4	13.4	20.2	16.0	12.8	20.2
4	18.4	15.0	22.5	18.3	14.7	23.4
5	20.4	16.3	25.5	20.4	16.2	25.5
6	22.9	18.0	29.1	22.8	17.7	30.2
7	25.8	20.5	33.7	25.9	19.8	37.9
8	29.1	22.7	39.4	28.8	21.7	41.0
9	32.0	24.0	43.9	32.7	24.2	45.7
10	35.6	26.7	51.8	37.1	27.8	52.9
11	40.2	29.3	55.2	42.4	28.9	62.3
12	44.8	31.0	63.1	47.5	34.4	66.0
13	50.8	35.0	71.6	51.8	38.9	70.6
14	56.4	39.0	79.7	56.7	41.3	80.3
15	62.9	47.1	85.6	58.4	43.6	79.2
2–15	32.9	14.3	64.6	32.8	13.8	62.6

Source: UK Office for National Statistics, 1999, modified from ECETOC, 2001

2.2 US-EPA

In the *Exposure Factors Handbook* (US-EPA, 2009), one "key study", a US-EPA analysis of NHANES 1999–2006 data, is the basis for the recommended values for body weight, see Table 2.4. The data were collected through direct measurements during a physical examination. The mean body weight for all adults combined is 80.0 kg. The US-EPA has noted that this mean recommended value is different from the 70 kg commonly assumed in the US-EPA risk assessments. The US-EPA therefore encouraged assessors to use the values which most accurately reflect the exposed population. When using values other than 70 kg, however, the assessors should consider if the dose estimate will be used to estimate risk by combining it with a dose-response relationship which was derived assuming a body weight of 70 kg. If such an inconsistency exists, the assessor should adjust the dose-response relationship. The Integrated Risk Information System (IRIS) does not use a 70 kg body weight assumption in the derivation of RfCs and RfDs, but does make this assumption in the derivation of cancer slope factors and unit risks. (US-EPA, 2009).

The values presented in Table 2.4 are well validated as the general assessment factors (GAFs, described in Section 1.2) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – high, 2. applicability and utility – high, 3. clarity and completeness – high, 4. variability and uncertainty – high, and 5. evaluation and review – medium; the overall rating was high. (US-EPA, 2009).

Values for body weight categorised by gender and for various adult age groups along with the 95th percentiles are presented in the Annex A, Table A.2.

In addition to the key study, 11 "relevant studies" were identified and presented in the EFH; however, most of them are old and were therefore not considered as representative for the US population of today due to the steep increase in body weight. One study, from 2008, includes a large sample size and was therefore considered as representative of the US population for the age groups presented. Data from this study is presented in the Annex A, Table A.3. Data for birth weight are presented in the Annex A, Table A.4, based on another relevant study.

Table 2.4: Recommended Values for Body Weight – as Presented in the Exposure Factors Handbook

Age group	Mean (kg)	5th Percentiles	95th Percentiles
0–<1 month	4.8	3.6	6.2
1–<3 months	5.6	4.5	7.3
3–<6 months	7.4	5.7	9.1
6–<12 months	9.2	7.1	11.3
1–<2 years	11.4	8.9	14.0
2–<3 years	13.8	10.9	17.1
3–<6 years	18.6	13.5	26.2
6–<11 years	31.8	19.7	52.5
11–<16 years	56.8	34.0	88.8
16–<21 years	71.6	48.2	108.0
Adults	80.0	-	-

Source: US-EPA analysis of NHANES, 1999–2006 data, modified from US-EPA, 2009

2.3 WHO

WHO standard values for body weight are those recommended by the ICRP (ICRP, 1974, cited in WHO/IPCS, 1994 and 1999). These values are presented in Table 2.5. It should be noted that WHO uses 60 kg for calculation of acceptable daily intakes and water quality guidelines.

Table 2.5: WHO's Standard Values for Body Weight

Sex	Body Weight (kg)
Men (Adults)	70
Women (Adults)	58
Men and Women Combined	64[a]

a) WHO uses 60 kg for calculation of acceptable daily intakes and water quality guidelines.

Source: Modified from WHO/IPCS, 1994 and 1999

2.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are more limited as are the WHO data.

In the REACH TGD Chapter R8 (ECHA, 2008a), the recommended values are stated as "taken from Gold et al., 1984 and ICRP, 1975"; however, it is not clear whether the recommendations are taken from one of these references or both. In the REACH TGD Chapter R15 (ECHA, 2008b) as well as in the report on the SCOOP data (Commission of the European Communities, 2001), no references for the recommended values are provided. The recommended values presented in the ConsExpo General Fact Sheet (RIVM, 2006a) are generated based upon data from the 1997 version of the EFH (US-EPA, 1997) and the recommendations from the ICRP (ICRP, 1992). The recommended values in ECETOC (ECETOC, 2001) are based on UK data published by the UK Office for National Statistics in 1998 (for adult body weight) and 1999 (for child body weight). The EFSA recommended values (EFSA, 2011) are taken from the EFSA

Comprehensive European Food Consumption Database (Comprehensive Database) published on the EFSA website.

The US-EPA recommended values for body weights presented in Table 2.4 are well validated and valid as the general assessment factors (GAFs, described in Section 1.2) were used to judge the quality of the underlying data used to derive the recommendations and as the US-EPA overall confidence rating was high. (US-EPA, 2009).

WHO standard values for body weight are those recommended by the ICRP (ICRP, 1974).

It should be noted that the references "ICRP, 1974", "ICRP, 1975" and "ICRP, 1992" are to the same ICRP report (ICRP Report No. 23).

Americans tend, in average to weigh more than Europeans. Despite this, the US-EPA recommended values for children are considered as being representative for European children as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for body weights as today as these values are based on an analyses of the most recent data (NHANES 1999–2006), whereas the European data are predominantly based on older references (ICRP, 1975; US-EPA, 1997; UK Statistics from 1999) or no references have been provided for the recommended values (e.g., REACH TGD Chapter R15). For adults, the currently most used value for average body weight of 70 kg for men and women combined is probably more representative for Europeans than the average US adult body weight of 80 kg. However, also in Europe, the adult body weight is increasing and therefore, probably approaching the American body weights of today.

In conclusion, the US-EPA recommended values presented in Table 2.4 are considered as being the most valid values for body weight as today and are therefore recommended as default exposure factors for assessments of European children in the context of REACH. For adults, however, the currently most used value for average body weight of 70 kg for men and women combined is still recommended as the default value for exposure assessments of the European population in the context of REACH. In addition to the average body weight for men and women combined, a default value of 70 kg for men and of 60 kg for women is recommended.

The recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides, cosmetics, toys etc.

3. Body Surface Areas

Dermal exposure can occur during a variety of activities in different environmental media and microenvironments (US-EPA, 2009), including:

- Water (e.g., bathing, washing, swimming)
- Soil (e.g., outdoor recreation, gardening, construction)
- Sediment (e.g., wading, fishing)
- Liquids (e.g., use of commercial products)
- Vapours/fumes (e.g., use of commercial products) and
- Indoor dust (e.g., carpets, floors, counter tops)

Dermal exposure can also occur via contact with articles and materials.

Surface area of the skin can be determined using measurement or estimation techniques. Coating, triangulation, and surface integration are direct measurement techniques that have been used to measure total body surface area and the surface area of specific body parts. The coating method consists of coating either the whole body or specific body regions with a substance of known density and thickness. Triangulation consists of marking the area of the body into geometric figures, then calculating the figure areas from their linear dimensions. Surface integration is performed by using a planimeter and adding the areas. (US-EPA, 2009).

3.1 Europe

The recommendations provided in the REACH *Guidance on information requirements and chemical safety assessment Chapter R15: Consumer exposure estimation* (ECHA, 2008b) on body surface areas, taken from the 1997 version of the *Exposure Factors* Handbook (US-EPA, 1997), are presented in Table 3.1.

Table 3.1: ECHA's Recommended Standard Values for Body Surface – as Presented in the REACH TGD Chapter R15

Body Part	Men (mean, cm^2)	Women (mean, cm^2)
Head (face)	1,180	1,028
Trunk	5,690	4,957
Upper Extremities	3,190	2,779
Arms	2,280	1,984
Upper Arms	1,430	1,244
Forearms	1,140	992
Hands (fronts and backs)	840	731
Lower Extremities	6,360	5,533
Legs	5,060	4,402
Thighs	1,980	1,723
Lower Legs	2,070	1,801
Feet	1,120	1,001
Total	19,400	16,900

Source: *Exposure Factors Handbook*, US-EPA, 1997, modified from ECHA, 2008b

In the *General Fact Sheet* (RIVM, 2006a), default values for body weight and surface area are generated based on data from the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997) and the ICRP *Report of the Task Group on Reference Man* (ICRP, 1992). Table B.1 in Annex B presents calculated default values generated upon the US-EPA bivariate equation (see below) and the US-EPA (1997) and ICRP data. The default values are 25^{th} percentiles.

For children, RIVM has also calculated default values for surface area, but by assuming that the relative surface area of the various parts of the body in children is dependent on age and not on weight or length, the default values are divided in age groups (RIVM, 2006a and 2002). Table B.2 in Annex B presents default values for children where the relative body surfaces "arms and legs" and "legs and feet" are not split up. Table B.3 presents default values for children where the data for "hands and arms" was split into the surface for the hands and the surface for the arms. For "legs and feet", the splitting up into "legs" and "feet" was carried out in a similar way. The data that these measurements are based upon include different age groups than in Table B.2, therefore, the age groups are different in Table B.3. This is also the reason for presenting two tables instead of just one.

According to the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), skin surface area can be calculated using the US-EPA bivariate equation for populations in which both body weight and height are known:

US-EPA bivariate equation:

$SA = a\ H^b\ W^c$, where

SA= Surface Area (m^2)

H = Height (cm)

W= Weight (kg)

a, b and c are constants (a = 0.0239, b = 0.417 and c = 0.517)

Source: US-EPA, 1989 – based on data from Murray and Burmaster, 1992.

Alternatively, when only body weight data are available, skin surface area can be calculated using either the equation of Costeff or Burmaster:

Costeff Equation:
SA = (4W + 7)/(W+90), where
SA = Surface Area (m^2)
W = Weight (kg)

Source: Costeff, 1966 in US-EPA (1997), based upon 220 observations of children

Burmasters Equation:
SA = a * BWc or ln SA = ln a + c ln BW, where
SA = Skin Surface Area
BW = Body Weight, and:
ln a = -2.2781, c = 0.6821 for all 401 people
ln a = -2.2752, c = 0.6868 for males
ln a = -2.2678, c = 0.6754 for females

Source: Burmaster, 1998, based upon 401 observations of adults and children

According to ECETOC (ECETOC, 2001), the equation of Burmaster may give a better estimate of central values than that of Costeff, but overestimates skin surface area at upper values. Based upon mean English adult body weight and the equation of Burmaster, total skin surface area is estimated as 2.07 m^2 for males and 1.76 m^2 for females, with an average of 1.92 m^2 (ECETOC, 2001). Distributions for several gender and age groups are presented in Annex B, Table B.4. Furthermore, ECETOC refers to the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997) for the use of body surface area standard values, see Table 3.1.

The clothes people wear function as protection against various types of exposure. The fraction of exposed skin surface depends upon climate and other aspects specific to a given exposure scenario, such as type of activity. Suggested defaults values of the percentage of the body that is exposed during some exposure scenarios from Exposure Factors Sourcebook for European Populations, with Focus on UK Data (ECETOC, 2001), are listed in Annex B, Table B.5. However, all kind of clothes are not 100 percent protective. Therefore, in the Technical Notes for Guidance on Human Exposure to Biocidal Products, TNsG (2007), default values of the protection factor of different sort of outfits are given and are listed in Annex B, Table B.6.

3.2 US-EPA

In the *Exposure Factors Handbook* (EFH) (US-EPA, 2009), two "key studies" and 3 "relevant studies" were identified. The recommendations for total body surface area are based on the most recent key study, which is a US-EPA analysis of weight and height 1999–2006 data from the National Health

and Nutrition Examination Survey (NHANES) for children under age 21 years and are presented for the standard age groupings recommended by US-EPA (US-EPA, 2005) for male and female children combined. For adults 21 years and over, the recommendations for total body surface area are based on a US-EPA analysis of NHANES 2005–2006 data. Recommended values for total body surface area are presented In Table 3.2. The recommendations for the percentage of total body surface area represented by individual body parts are presented in Table 3.3.

The values presented in Table 3.2 and 3.3 are well validated as the general assessment factors (GAFs, described in Section 1.2) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium, 2. applicability and utility – medium, 3. clarity and completeness – medium, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was medium for "total surface area" and low for "surface area of individual body parts." (US-EPA, 2009).

In Annex B, Table B.7 presents the mean percent of surface area for children categorized per year based upon data from the above-mentioned studies and Table B.8 presents surface area of adults (21+ years) in square meters in more detailed body parts than those presented in Table 3.3.

Table 3.2: Recommended Values for Total Body Surface Area for Children (Genders Combined) and Adults by Gender – as Presented in the Exposure Factors Handbook

Age (group)	Mean (m^2)	95th Percentile (m^2)
Children		
0–1 month	0.29	0.34
1–<3 months	0.33	0.38
3–<6 months	0.38	0.44
6–<12 months	0.45	0.51
1–<2 years	0.53	0.61
2–<3 years	0.61	0.70
3–<6 years	0.76	0.95
6–<11 years	1.08	1.48
11–<16 years	1.59	2.06
16–<21 years	1.84	2.33
Adult Men		
21–<30 years	2.05	2.52
30–<40 years	2.10	2.50
40–<50 years	2.15	2.56
50–<60 years	2.11	2.55
60–<70 years	2.08	2.46
70–<80 years	2.05	2.45
≥80 years	1.92	2.22
Adult Women		
21–<30 years	1.81	2.25
30–<40 years	1.85	2.31
40–<50 years	1.88	2.36
50–<60 years	1.89	2.38
60–<70 years	1.88	2.34
70–<80 years	1.77	2.13
≥80 years	1.69	1.98

Source: US-EPA Analysis of NHANES 1999–2006 data, modified from US-EPA, 2009.

Table 3.3: The values in the table have been changed according to the final EPA report. Recommended Values of Surface Area of Body Parts for Children (Genders Combined) and Adults by Gender – as Presented in the Exposure Factors Handbook

Age	Head	Trunk	Arms	Hands	Legs	Feet
	Mean Percent of Total Surface Area (%)					
Children						
0–1 m	18.2	35.7	13.7	5.3	20.6	6.5
1–<3 m	18.2	35.7	13.7	5.3	20.6	6.5
3–<6 m	18.2	35.7	13.7	5.3	20.6	6.5
6–<12 m	18.2	35.7	13.7	5.3	20.6	6.5
1–<2 y	16.5	35.5	13.0	5.7	23.1	6.3
2–<3 y	8.4	41.0	14.4	4.7	25.3	6.3
3–<6 y	8.0	41.2	14.0	4.9	25.7	6.4
6–<11 y	6.1	39.6	14.0	4.7	28.8	6.8
11–<16 y	4.6	39.6	14.3	4.5	30.4	6.6
16–<21 y	4.1	41.2	14.6	4.5	29.5	6.1
Adult Men						
≥21 y	6.6	40.1	15.2	5.2	33.1	6.7
Adult Women						
≥21 y	6.2	35.4	12.8	4.8	32.3	6.6

	Surface Area (m^2)											
	Mean[a]	95th [b]	Mean[a]	95th [b]	Mean[a]	95th [b]	Mean[a]	95th [b]	Mean[a]	95th [b]	Mean[a]	95th [b]
Children												
0–1 m	0.053	0.062	0.104	0.121	0.040	0.047	0.015	0.018	0.060	0.070	0.019	0.022
1–<3 m	0.060	0.069	0.118	0.136	0.045	0.052	0.017	0.020	0.068	0.078	0.021	0.025
3–<6 m	0.069	0.080	0.136	0.157	0.052	0.060	0.020	0.023	0.078	0.091	0.025	0.029
6–<12 m	0.082	0.093	0.161	0.182	0.062	0.070	0.024	0.027	0.093	0.105	0.029	0.033
1–<2 y	0.087	0.101	0.188	0.217	0.069	0.079	0.030	0.035	0.122	0.141	0.033	0.038
2–<3 y	0.051	0.059	0250	0.287	0.088	0101	0.028	0.033	0.154	0.177	0.038	0.044
3–<6 y	0.061	0.076	0.313	0.391	0.106	0.133	0.037	0.046	0.195	0.244	0.049	0.061
6–<11 y	0.066	0.090	0.428	0.586	0.151	0.207	0.051	0.070	0.311	0.426	0.073	0.100
11–<16 y	0.073	0.095	0630	0.816	0.227	0.295	0.072	0.093	0.483	0.626	0.105	0.136
16–<21 y	0.075	0.096	0.759	0.960	0.269	0340	0.083	0.105	0.543	0.687	0.112	0.142
Adult Men												
≥21 y	0.136	0.154	0.827	1.100	0.314	0.399	0.107	0.131	0.682	0.847	0.137	0.161
Adult Women												
≥21 y	0.114	0.121	0.654	0.850	0.237	0.266	0.089	0.106	0.598	0.764	0.122	0.146

a) Calculated as mean percentage of body part times mean total body surface area.

b) Calculated as mean percentage of body part times 95th percentile total body surface area.

Note: Surface area values reported in m^2 can be converted to cm^2 by multiplying by 10,000 cm^2/m^2.

Source: US-EPA Analysis of NHANES 1999–2006 data and US-EPA, 1985, modified from US-EPA, 2009.

Please note that there are no changes for adults.

3.3 WHO

No recommendations on body surface area are provided by WHO.

3.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) as well as the European data are comprehensive. No recommendations have been provided by the WHO.

In the REACH TGD Chapter R15 (ECHA, 2008b), the recommended values presented in Table 3.1 are taken from the 1997 version of the EFH (US-EPA, 1997). The recommended values presented in the ConsExpo General Fact Sheet (RIVM, 2006a) are generated based upon data from the 1997 version of the EFH (US-EPA, 1997) and the recommendations from the ICRP (ICRP, 1992). It should be noted that the reference "ICRP, 1992" is to the "ICRP, 1974" / "ICRP, 1975" report (ICRP Report No. 23). The recommended values from ECETOC (ECETOC, 2001) are calculated based upon UK body weight data and different equations. Furthermore, ECETOC refers to the 1997 version of the EFH (US-EPA, 1997) for the use of body surface area standard values.

The US-EPA recommended values for body surface areas presented in Table 3.2 and 3.3 are well validated as the general assessment factors (GAFs, described in Section 1.2) were used to judge the quality of the underlying data used to derive the recommended values. The US-EPA overall rating was medium for "total surface area" and low for "surface area of individual body parts". (US-EPA, 2009).

Americans tend, in average, to weigh more and thus to have a greater body surface area than Europeans. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for body surface areas as today as these values are based on analyses of the most recent data (NHANES 1999–2006), whereas the European data are predominantly based on older data, primarily the 1997 version of the EFH (US-EPA, 1997). However, also in Europe, the adult body weight is increasing and thus, also the body surface area and therefore, probably approaching the American body weights and body surface area of today.

In conclusion, the US-EPA recommended values presented in Table 3.2 and 3.3 are considered as being the most valid values for body surface areas as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

The recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides, cosmetics, toys etc.

4. Inhalation rates

Outdoor (ambient) and indoor air are potential sources of exposure to toxic substances. Adults and children can be exposed to contaminated air during a variety of activities in different environments. They may be exposed to contaminants in ambient air, and may also inhale chemicals from the indoor use of various consumer products. (US-EPA, 2009).

Due to their size, physiology, and activity level, the inhalation rates of children differ from those of adults. Infants and children have a higher resting metabolic rate and oxygen consumption rate per unit of body weight than adults, because of their rapid growth and relatively larger lung surface area per unit of body weight that requires cooling. Thus, while greater amounts of air and pollutants are inhaled by adults than children over similar time periods on an absolute basis, the volume of air passing through the lungs of a resting infant is up to twice that of a resting adult on a body weight basis. (US-EPA, 2009).

4.1 Europe

In the *REACH Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a), an inhalation volume of 20 m^3/day is recommended for exposure assessments of consumers and man exposed indirectly via the environment, and of 10 m^3/8 hours light work for exposure assessments of workers (Table R. 8–18).

The recommendations provided in the REACH Guidance on information requirements and chemical safety assessment Chapter R8 (ECHA, 2008a) Table R. 8–2 and in the REACH Guidance on information requirements and chemical safety assessment Chapter R15: Consumer exposure estimation (ECHA, 2008b) Tables R.15–14 to R.15–16 on respiratory volumes are presented in Table 4.1.

Table 4.1: ECHA's Recommended Standard Values for Respiratory Volume – as Presented in the REACH TGD Chapter R8 and R15

Body Weight [a, b]	**70 kg**
Respiratory Volume [b]	0.2 L/min/kg
For relevant duration [b]	
6 hour exposure	5 m^3/person
8 hour exposure	6.7 m^3/person
24 hour exposure	20 m^3/person
Respiratory Volume Light Activity for Worker [a, b]	
8 hour exposure	10 m^3/person
Respiratory Volume Related to Activity Level [c] **(Men:20–30 years; Women: 20–33 years)**	
Resting	
Men	6.5–10.8 m^3/day
Women	6.5–8.6 m^3/day
Pregnant Women	14 m^3/day
Light Activity	
Men	29–42 m^3/day
Women	23–27 m^3/day
Medium Activity	
Men	62 m^3/day
Women	36 m^3/day
Heavy Activity	
Men	160 m^3/day
Women	130 m^3/day
Respiratory Volume for Short-Term Exposure [c]	
Resting, Children	
<1 year	1.4 m^3/day
1–3 years	2.9 m^3/day
4–6 years	5.8 m^3/day
7–9 years	8.6 m^3/day
10–14 years	12 m^3/day
Resting, Adolescents	
15–19 years	13 m^3/day
Resting, Adults	
20–75 years	13 m^3/day
Light Activity, Children	
<1 year	2.9 m^3/day
1–3 years	5.8 m^3/day
4–6 years	12 m^3/day
7–9 years	12 m^3/day
10–14 years	23 m^3/day
Light Activity, Adolescents	
15–19 years	26 m^3/day
Light Activity, Adults	
20–75 years	26 m^3/day
Medium Activity, Children	
<1 year	5.8 m^3/day
1–3 years	12 m^3/day
4–6 years	23 m^3/day
7–9 years	35 m^3/day
10–14 years	46 m^3/day
Medium Activity, Adolescents	
15–19 years	51 m^3/day
Medium Activity, Adults	
20–75 years	51 m^3/day
Heavy Activity, Children	
<1 year	10 m^3/day
1–3 years	20 m^3/day
4–6 years	40 m^3/day
7–9 years	61 m^3/day
10–14 years	81 m^3/day
Heavy Activity, Adolescents	
15–19 years	91 m^3/day
Heavy Activity, Adults	
20–75 years	91 m^3/day

Body Weight [a, b]	70 kg
Respiratory Volume for a Whole Day Exposure [c]	
Children	
<1 year	3 m^3/day
1–3 years	7 m^3/day
4–6 years	11 m^3/day
7–9 years	14 m^3/day
10–14 years	18 m^3/day
Adolescents	
15–19 years	20 m^3/day
Adults	
20–75 years	18 m^3/day

Sources: a: ECHA, 2008a (Taken from Gold et al., 1984 and ICRP, 1975 – cited in ECHA, 2008a); b: ECHA, 2008a (no reference(s) provided for default physiological parameters in Table R. 8–2 – cited in ECHA, 2008a); and c: ECHA, 2008b (Taken from AUH, 1995 – cited in ECHA, 2008b)

In the Preparation of a Guidance Document on Pesticide Exposure; Assessment for Workers, Operators, Bystanders and Residents (EFSA, 2010), the recommendations regarding inhalation rates are based upon the data from the 2009 version of the US-EPA Exposure Factors Handbook (US-EPA, 2009) and are presented in Table 4.2.

Table 4.2: Inhalation Rates recommended by EFSA

Age group	Inhalation rate
Daily Inhalation Rate; long term exposure	
<1 year	1.14 m^3/day/kg
1–<3 years	1.07 m^3/day/kg
3–<6 years	0.70 m^3/day/kg
6–<11 years	0.44 m^3/day/kg
11–<16 years	0.27 m^3/day/kg
Adults	0.23 m^3/day/kg
Short term exposure (< 30 min); high intensity hourly exposure	
<1 year	0.196 m^3/hour/kg
1–<3 years	0.190 m^3/hour/kg
3–<6 years	0.120 m^3/hour/kg
6–<11 years	0.082 m^3/hour/kg
11–<16 years	0.055 m^3/hour/kg
Adults	0.040 m^3/hour/kg

Source: EFSA, 2010

The Danish Environmental Protection Agency (D-EPA) has in their Guidance from the Environmental Protection Agency No. 5 (D-EPA, 2006) based their recommended inhalation rate upon data in the 1997 version of the US-EPA Exposure Factors Handbook (US-EPA, 1997). A default value 0.5 m^3 air/kg bw for children aged one to five is recommended (D-EPA, 2006).

In the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), the recommended long-term and short-term inhalation rates are taken from the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997). ECETOC has noted that these values are based upon US data, but are probably representative of Europeans as well, see Table 4.3 and 4.4.

Table 4.3: Values for Long-term Inhalation Rates recommended by ECETOC – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Population	Gender	Mean m^3/day
Infants:		
< 1 year	-	4.5
Children:		
1–2 years	-	6.8
3–5 years	-	8.3
6–8 years	-	10.0
9–11 years	Female	13.0
9–11 years	Male	14.0
12–14 years	Female	12.0
12–14 years	Male	15.0
15–18 years	Female	12.0
15–18 years	Male	17.0
Adults:		
19–65 years	Female	11.3
19–65 years	Male	15.2

Source: US-EPA, 1997, modified from ECETOC, 2001

Table 4.4: Values for Short-term Inhalation Rates recommended by ECETOC – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Population	Activity Level	Mean m^3/hour
Adults:		
	Rest	0.4
	Sedentary	0.5
	Light	1.0
	Moderate	1.6
	Heavy	3.2
Children:		
	Rest	0.3
	Sedentary	0.4
	Light	1.0
	Moderate	1.2
	Heavy	1.9
Outdoor Workers:		
	Slow	1.1
	Moderate	1.5
	Heavy	2.5
	Hourly Average	1.3 (upper percentile of 3.3)

Source: US-EPA, 1997, modified from ECETOC, 2001

4.2 US-EPA

In the *Exposure Factors Handbook* (EFH) (US-EPA, 2009), four "key studies" and 13 "relevant studies" were identified. The recommended inhalation rates for adults and children are based on three recent key studies as well as an additional recent study of children. The US-EPA has noted that these key studies represent an improvement upon those previously used for recommended inhalation rates in previous versions of the EFH, because they have used a large data set that is representative of the US as a whole and consider the correlation between body weight and inhalation rate (US-EPA, 2009). It was also noted that the selection of inhalation rates to be used for exposure assessments depends on the age of the

exposed population and the specific activity levels of this population during various exposure scenarios (US-EPA, 2009).

The recommended long-term inhalation rates (m^3/day) for adults and children (including infants) for use in various exposure scenarios are presented in Table 4.5. The values are at least averages of two of the key studies. The US-EPA (US-EPA, 2009) has defined long-term exposure as *"repeated exposure for more than 30 days, up to approximately 10% of the life span in humans (more than 30 days)"* The US-EPA has noted that all of the 95th percentile values represent unusually high inhalation rates for long-term exposures, even for the upper end of the distribution, but that they were included in the EFH to provide exposure assessors a sense of the possible range of inhalation rates for adults and children. Therefore, the US-EPA advices that these values should be used with caution when estimating long-term exposures.

Table 4.5: Recommended Long-Term Exposure Values for Inhalation – as Presented in the Exposure Factors Handbook

Inhalation Rate – Long-Term Exposure		
	Mean m^3/day	95th Percentile m^3/day
Infants:		
Birth to 1 month	3.6	7.1
1–<3 months	3.5	5.8
3–<6 months	4.1	6.1
6–<12 months	5.4	8.0
Birth to <1 year	5.4	9.2
Children:		
1–<2 years	8.0	12.8
2–<3 years	8.9	13.7
3–<6 years	10.1	13.8
6–<11 years	12.0	16.6
11–<16 years	15.2	21.9
16–<21 years	16.3	24.6
Adults (over 21 years):		
21–<31 years	15.7	21.3
31–<41 years	16.0	21.4
41–<51 years	16.0	21.2
51–<61 years	15.7	21.3
61–<71 years	14.2	18.1
71–<81 years	12.9	16.6
≥81 years	12.2	15.7

Source: Modified from US-EPA, 2009

In order to present more detailed information of long-term inhalation rates stratified by sex and weight, additional tables are included in Annex C: Table C.1 presents daily inhalation rates from free-living (opposite to staged activity measures) normal-weight men and women. Table C.2 and C.3 present daily physiological inhalation rates (a specific method for estimation of inhalation rates, calculated as described in footnote b to Table C.2) for free-living normal-weight men and women aged 2.6 months to 96 years, and for free-living normal-weight and overweight/obese men and women aged 4 to 96 years, respectively. Table C.4 and C.5 are equal to Table C.2 and C.3, but adjusted by body weight. Table C.6 presents daily physiological inhalation rates for newborns

aged one month or less. Table C.1 to C.6 are all based upon one single key study (Brochu et al., 2006, in the 2009 version of the EFH). Table C.7 and C.8 present inhalation rates for men and women unadjusted and adjusted for body weight, respectively, based upon another single key study (US-EPA, 2009, in the 2009 version of the EFH).

The recommended short-term inhalation rates (m^3/minute) are presented in Table 4.6 for men and women combined, for adults and children for which activity patterns are known. These values represent averages of the activity level data from the one key study from which short-term inhalation rate data were available. The US-EPA (US-EPA, 2009) has defined short-term exposure as "*repeated exposure for more than 24 hours, up to 30 days.*"

Each activity pattern was assigned a metabolic equivalents (METS) value based on statistical sampling of the distribution assigned by CHAD (the US-EPA's Consolidated Human Activity Database) to each activity code. The inhalation rate for each activity within the 24-hour simulated activity pattern for each individual was estimated as a function of VO_2 (oxygen consumption rate), body weight, age, and gender. Following this, the average inhalation rate was calculated for each individual for the entire 24-hour period, as well as for four separate classes of activities based on METS value: Sedentary/passive, METS less than or equal to 1.5; light intensity, METS greater than 1.5 and less than or equal to 3.0; moderate intensity, METS greater than 3.0 and less than or equal to 6.0; and high intensity, METS greater than 6.0 (US-EPA, 2009). In the Annex, short-term inhalation rates for gender and age categories on a volumetric (m^3/day) and body-weight adjusted (m^3/day-kg) basis are presented Table C.9 and C.10, respectively.

Table 4.6: Recommended Short-Term Exposure Values for Inhalation Rates[a] – as Presented in the Exposure Factors Handbook

Age (years)	Sleep or Nap		Sedentary/Passive		Light Intensity		Moderate Intensity		High Intensity	
	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min
0–<1	3.0E-03	4.6E-03	3.1E-03	4.7E-03	7.6E-03	1.1E-02	1.4E-02	2.2E-02	2.6E-02	4.1E-02
1	4.5E-03	6.4E-03	4.7E-03	6.5E-03	1.2E-02	1.6E-02	2.1E-02	2.9E-02	3.8E-02	5.2E-02
2	4.6E-03	6.4E-03	4.8E-03	6.5E-03	1.2E-02	1.6E-02	2.1E-02	2.9E-02	3.9E-02	5.3E-02
3–<6	4.3E-03	5.8E-03	4.5E-03	5.8E-03	1.1E-02	1.4E-02	2.1E-02	2.7E-02	3.7E-02	4.8E-02
6–<11	4.5E-03	6.3E-03	4.8E-03	6.4E-03	1.1E-02	1.5E-02	2.2E-02	2.9E-02	4.2E-02	5.9E-02
11–<16	5.0E-03	7.4E-03	5.4E-03	7.5E-03	1.3E-02	1.7E-02	2.5E-02	3.4E-02	4.9E-02	7.0E-02
16–<21	4.9E-03	7.1E-03	5.3E-03	7.2E-03	1.2E-02	1.6E-02	2.6E-02	3.7E-02	4.9E-02	7.3E-02
21–<31	4.3E-03	6.5E-03	4.2E-03	6.5E-03	1.1E-02	1.6E-02	2.6E-02	3.8E-02	5.0E-02	7.6E-02
31–<41	4.6E-03	6.6E-03	4.3E-03	6.6E-03	1.1E-02	1.6E-02	2.7E-02	3.7E-02	4.9E-02	7.2E-02
41–<51	5.0E-03	7.1E-03	4.8E-03	7.0E-03	1.2E-02	1.6E-02	2.8E-02	3.9E-02	5.2E-02	7.6E-02
51–<61	5.2E-03	7.5E-03	5.0E-03	7.3E-03	1.2E-02	1.7E-02	2.9E-02	4.0E-02	5.3E-02	7.8E-02
61–<71	5.2E-03	7.2E-03	4.9E-03	7.3E-03	1.1E-02	1.6E-02	2.6E-02	3.4E-02	4.7E-02	6.6E-02
71–<81	5.3E-03	7.2E-03	5.0E-03	7.2E-03	1.1E-02	1.5E-02	2.5E-02	3.2E-02	4.7E-02	6.5E-02
≥81	5.2E-03	7.0E-03	4.9E-03	7.0E-03	1.1E-02	1.6E-02	2.5E-02	3.1E-02	4.8E-02	6.8E-02

a) An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999–2002.

Source: US-EPA, 2009, modified from US-EPA, 2009.

The US-EPA recommended values for inhalation rates presented in Table 4.5 and 4.6 for long-term and short-term exposure, respectively, are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium, 2. applicability and utility – high, 3. clarity and completeness – medium, 4. variability and uncertainty – medium, and 5. evaluation and review – high; the overall rating was medium. (US-EPA, 2009).

4.3 WHO

WHO standard values for respiratory volumes (average figures) are those recommended by the ICRP (ICRP, 1974, cited in WHO/IPCS, 1994 and 1999). These values are presented in Table 4.7.

Table 4.7: WHO's Standard Values for Respiratory Volumes

Condition	Respiratory Volume (Average)
Long-term exposure (8 hours resting, 16 hours light/non-occupational activity):	
Child (10 Years)	15 m^3/day
Adult Man	23 m^3/day
Adult Woman	21 m^3/day
Men and Women Combined	22 m^3/day
Short-Time Exposure:	
Resting	
Child (10 Years)	2300 L/8 hour
Adult Man	3600 L/8 hour
Adult Woman	2900 L/8 hour
Light/Nonoccupational Activity	
Child (10 Years)	6240 L/8 hour
Adult Man	9600 L/8 hour
Adult Woman	9100 L/8 hour

Source: Modified from WHO/IPCS, 1994 and 1999

4.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited as are the WHO data.
In the REACH TGD Chapter R8 (ECHA, 2008a), the recommended values in Table R. 8–18 are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommended values are taken from one of these references or both; there are no references provided for the default physiological parameters presented in Table R. 8–2. In the REACH TGD Chapter R15 (ECHA, 2008b), the recommended values presented in Table 4.1 are taken from a German document (AUH, 1995).

The EFSA (EFSA, 2010) recommended values (Table 4.2) are based upon data from the 2009 version of the EFH (US-EPA, 2009). The Danish Environmental Protection Agency (D-EPA, 2006) has based their recom-

mended values on the 1997 version of the EFH (US-EPA, 1997). The recommended values from ECETOC (ECETOC, 2001) presented in Table 4.3 and 4.4 for long-term and short-term exposure, respectively, are taken from the 1997 version of the EFH (US-EPA, 1997) as ECETOC has considered that these values are probably representative of Europeans as well.

The US-EPA recommended values for inhalation rates presented in Table 4.5 and 4.6 for long-term and short-term exposure, respectively, are well validated and valid as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations and as the US-EPA overall confidence rating was medium. (US-EPA, 2009).

The WHO's standard values (Table 4.7) are based on recommendations from the ICRP (ICRP, 1974).

It should be noted that the references "ICRP, 1974" and "ICRP, 1975" are to the same ICRP report (ICRP Report No. 23).

Activity levels might be different among US individuals compared to Europeans. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for inhalation rates as today as these recommendations are based on four recent key studies published in the period from 2006–2009. In addition, the US-EPA has noted that these key studies represent an improvement upon those previously used for recommended inhalation rates in previous versions of the EFH. In contrast, the European data are predominantly based on older references (ICRP, 1975; AUH 1995, US-EPA, 1997) or no references have been provided for the recommended values (e.g., REACH TGD Chapter R8, Table R. 8–2). One European body, namely EFSA (EFSA; 2010) has based their recommended values on the most recent version of the EFH (US-EPA, 2009). It should also be noted that ECETOC has considered that the American values are probably representative of Europeans as well.

In conclusion, the US-EPA recommended values presented in Table 4.5 and 4.6 are considered as being the most valid values for inhalation rates as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

The recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides, cosmetics, toys etc.

5. Drinking Water

Drinking water is a potential source of human exposure to chemical substances, naturally occurring or contaminants. Contamination of drinking water may occur by, for example, percolation of chemicals through the soil to ground water that is used as a source of drinking water; runoff or discharge to surface water that is used as a source of drinking water, intentional or unintentional addition of substances to treat water (e.g., chlorination), and leaching of materials from plumbing systems (e.g., lead). The exposure is usually expressed as an average amount of drinking water consumed per unit time (e.g., litre/day).

For the estimation of the magnitude of the potential dose of chemicals from drinking water, information on the quantity of water consumed per unit time is required. The intake of drinking water depends on age, level of physical activity (working, running, walking, or resting), and the ambient temperature.

For the purposes of exposure assessments involving site-specific contaminated drinking water, ingestion rates based on the community supply are most appropriate. Given the assumption that bottled water, and purchased foods and beverages that contain water are widely distributed and less likely to contain source-specific water, the use of total water ingestion rates may overestimate the potential exposure to toxic substances present only in local water supplies (US-EPA, 2009); therefore, tap water ingestion rather than total water ingestion, is emphasized in this report.

5.1 Europe

In the REACH *Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a) the standard value for daily water intake is 2.0 litres. This is also recommend by The EFSA Scientific Committee as a conservative default value for daily total liquid intake in adults (*Draft Guidance on Default Assumptions 2011*).

The Danish Environmental Protection Agency (D-EPA) has in their *Guidance from the Environmental Protection Agency No. 5* (D-EPA, 2006) based their recommended intake of tap water upon data in the *Exposure Factors Handbook* (US-EPA, 1997). For newborns, the mean intake is 35 ml/kg bw/day, while the 95th percentile is 127 ml/kg bw/day. For children aged one to ten years, the mean intake is set to 31 ml/kg bw/day and the 95th percentile is 79.4 ml/kg bw/day (D-EPA, 2006). It was considered most applicable to use the values for children (one to ten years)

due to possible differences in breastfeeding patterns in Denmark and USA. These differences across countries may be important for the intake of tap water for newborns (D-EPA, 2006).

In the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001) an average value of 1.1 litre/day for adults and 0.5 litre/day for 1–11 year olds is recommended based upon a 1980 survey of Great Britain (Hopkin and Ellis, 1980, as cited in the 1997 version of the EFH (US-EPA, 1997)), see Table 5.1. This survey, included in the 2009 version of the EFH (US-EPA, 2009) as a "relevant study" was based on questionnaires and diaries indicating the type and quantity of beverages consumed over a one-week period. In the survey, drinking water is estimated as total tap water ingestion, which includes tap water consumed directly and in prepared items such as tea, coffee and other drinks, excludes water ingestion from bottled beverages. Because bottled items are likely to originate from different water sources (US-EPA, 1997), total tap water ingestion is therefore, according to ECETOC a better estimation of intake from the greatest single water source. (ECETOC, 2001).

Table 5.1: Summary of Total Tap water Intake for Men and Women (litre/day) – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Age Group (years)	Mean Intake (litre/day)		10 and 90 Percentiles (litre/day)	
	Men	Women	Men	Women
1–4	0.477	0.464	0.17–0.85	0.15–0.89
5–11	0.550	0.533	0.22–0.90	0.22–0.93
12–17	0.805	0.725	0.29–1.35	0.31–1.16
18–30	1.006	0.991	0.45–1.62	0.50–1.55
31–54	1.201	1.091	0.64–1.88	0.62–1.68
55+	1.133	1.027	0.62–1.72	0.54–1.57

Source: US-EPA (1997) citation of Hopkin and Ellis, 1980, modified from ECETOC, 2001

5.2 US-EPA

In the *Exposure Factors Handbook* (EFH) (US-EPA, 2009) consumption of food and water is divided into "per capita" and "consumers only." Per capita intake rate is "*the average quantity of food consumed per person in a population composed of both individuals who ate the food during a specified time period and those that did not.*" Consumer-only intake rate on the other hand, is "*the average quantity of food consumed per person in a population composed only of individuals who ate the food item of interest during a specified period.*"

Historically, the US-EPA has assumed a drinking water ingestion rate of 2 L per day for adults and 1 L per day for infants and children less than 10 years of age (US-EPA, 2000). This rate includes water consumed in the form of juices and other beverages containing tap water.

In the EFH, two "key studies" and 22 "relevant studies" were identified. The key studies (Kahn, 2008 and Kahn & Stralka, 2008a) were iden-

tified based on the applicability of the survey design to exposure assessments of the entire US population. A total of approximately 20,000 individuals were included in the surveys. The data were collected by an in-home interviewer on a recall basis on two non-consecutive days within ten days using standardized volumes of drinking water containers. The recommended exposure factors for drinking water – based on the two key studies – are presented in Table 5.2. A third (Kahn & Stralka, 2008b) forms the basis for the recommended exposure factors for pregnant and lactating women.

The recommended values presented in Table 5.2 are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. For children and adults, the US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium to high, 2. applicability and utility – medium, 3. clarity and completeness – high, 4. variability and uncertainty – high, and 5. evaluation and review – medium; the overall rating was medium to high. For pregnant/lactating women, the US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – low, 2. applicability and utility – low-medium, 3. clarity and completeness – medium, 4. variability and uncertainty – low, and 5. evaluation and review – medium; the overall rating was low. (US-EPA, 2009).

One of the relevant studies (Heller et al., 2000, cited from US-EPA, 2009) provides information on tap water and total water consumption by age and sex using the same survey as the two key studies, see Table D.1 in Annex D.

Table 5.2: Recommended Values for Intake of Drinking Water as Presented in the Exposure Factors Handbooka)

Age group	Mean (ml/day)	Mean (ml/kg bw/day)	95th Percentile (ml/day)	95th Percentile (ml/kg bw/day)
Per Capita				
Children				
Birth to <1 month	184	52	839	232
1 to <3 month	227	48	896	205
3 to <6 month	362	52	1,056	159
6 to <12 month	360	41	1,055	126
1 to <2 years	271	23	837	71
2 to <3 years	317	23	877	60
3 to <6 years	380	22	1,078	61
6 to <11 years	447	16	1,235	43
11 to <16 years	606	12	1,727	34
16 to <18 years	731	11	1,983	31
18 to <21 years	826	12	2,540	35
Adults				
≥ 21 years	1,104	15	2,811	39
> 65 years	1,127	15	2,551	37
All ages	926	16	2,544	43
Pregnant women	819	13	2,503	43
Lactating women	1,379	21	3,434	55
Consumers Only				

Age group	Mean (ml/day)	Mean (ml/kg bw/day)	95th Percentile (ml/day)	95th Percentile (ml/kg bw/day)
Children				
Birth to <1 month	470	137	858	238
1 to <3 month	552	119	1,053	285
3 to <6 month	556	80	1,171	173
6 to <12 month	467	53	1,147	129
1 to <2 years	308	27	893	75
2 to <3 years	356	26	912	62
3 to <6 years	417	24	1,099	65
6 to <11 years	480	17	1,251	45
11 to <16 years	652	13	1,744	34
16 to <18 years	792	12	2,002	32
18 to <21 years	895	13	2,565	35
Adults				
≥ 21 years	1,183	16	2,848	39
> 65 years	1,242	18	2,604	37
All ages	1,000	17	2,601	43
Pregnant women	872	14	2,589	43
Lactating women	1,665	26	3,588	55

a) Ingestion rates for combined direct (direct consumption of water as a beverage) and indirect (includes water added during food preparation, but not water intrinsic to purchased foods (i.e. water that is naturally contained in foods)) water from community water supply.

Source: Kahn, 2008 and Kahn & Stralka, 2008a, b, modified from US-EPA, 2009.

5.3 WHO

Table 5.3 presents WHO's standard values of daily fluid intake for different conditions based on recommendations from the ICRP (ICRP, 1974 – cited in WHO/IPCS, 1994 and 1999).

In developing drinking water guideline values for potentially hazardous chemicals, the WHO (WHO, 2008) assumes a daily per capita consumption of 2 litres of drinking water by a person weighing 60 kg. This standard value is considered to be on the safe side in most situations. But under certain circumstances, this assumption may underestimate the consumption of water per unit weight, and thus exposure, for those living in hot climates as well as for infants and children, who consume more fluid per unit weight than adults. Where it was judged that children were at a particularly high risk from exposure to certain chemicals, the drinking water guideline value was derived on the basis of a 10-kg child consuming 1 litre of drinking water per day, or a 5-kg infant consuming 0.75 litre per day. The corresponding daily fluid intakes are higher than for adults on a body weight basis (WHO, 2008).

Table 5.3: WHO's Standard Values for Daily Fluid Intake

Condition	Daily Fluid Intake (ml/day) (milk, tap water, other beverages)
Normal Conditions	
Adults	1000–2400, representative figure=1900[a] (excluding milk: 1400[b])
Adult Men	1950
Adult Women	1400
Child (10 years)	1400
High Average Temperature (32°C)	
Adults	2840–3410
Moderate Activity	
Adults	3700

a) WHO uses a daily per capita drinking-water consumption of 2 litres in calculating water quality guidelines.

b) From Health and Welfare Canada, 1992.

Source: Modified from WHO/IPCS, 1994 and 1999.

5.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited as are the WHO data.

In the REACH TGD Chapter R8 (ECHA, 2008a), the recommended values are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommendations are taken from one of these references or both. The Danish Environmental Protection Agency (D-EPA, 2006) has based their recommendations on the 1997 version of the EFH (US-EPA, 1997).

The recommended values from ECETOC (ECETOC, 2001) presented in Table 5.1 are based upon a thirty-year old survey as it has been described in the 1997 version of the EFH (US-EPA, 1997). This survey is included in the 2009 version of the EFH (US-EPA, 2009) as a "relevant study" and the US-EPA has evaluated that the advantage of the data in this survey is that the responses were not generated on a recall basis, but by recording daily intake in diaries, which may result in more accurate responses being generated. But as the data were based on the population of Great Britain and not the United States and as drinking patterns may differ among these populations as a result of varying weather conditions and socio-economic factors, this survey was not considered as a "key study" in the 2009 version of the EFH.

The US-EPA recommended values for intake of drinking water presented in Table 5.2 are well validated and valid as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. For children and adults, the US-EPA overall rating was medium to high. For pregnant/lactating women, the US-EPA overall rating was low. (US-EPA, 2009).

The WHO's standard values of daily fluid intake (Table 5.3) are based on recommendations from the ICRP (ICRP, 1974).

It should be noted that the references “ICRP, 1974” and “ICRP, 1975” are to the same ICRP report (ICRP Report No. 23).

The intake of bottled beverages may be more common today than it was thirty years ago. Therefore, the more recent recommendations from the US-EPA may be more representative of the intake of tap water as today compared to the recommended values from ECETOC, which have been based upon a thirty-year old survey as it has been described in the 1997 version of the EFH (US-EPA, 1997). However, it is possible that the US population consumes more bottled beverages than the European population and that the US data therefore underestimate the actual intake of tap water consumed by the European population. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for intake of drinking water as today as these recommendations are based on two very recent key studies published in 2008. In contrast, the European data are predominantly based on older references (ICRP, 1975; US-EPA, 1997).

In conclusion, the US-EPA recommended values presented in Table 5.2 are considered as being the most valid values for intake of drinking water as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

The recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides etc.

6. Food Intake

Even though food supply in the western world is generally considered to be safe, contamination of foods may occur as a result of environmental pollution of the air, water, or soil, or the intentional use of chemicals such as pesticides or other agrochemicals. Ingestion of contaminated foods is a potential pathway of exposure to such contaminants. To assess chemical exposure through this pathway, information on food ingestion rates is needed. (US-EPA, 2009).

6.1 Europe

The standard value for total food intake in the *REACH Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a) is appointed to 1.4 kg per day.

The National Food Institute, Technical University of Denmark, has investigated the dietary habits of the Danish population in a document called Dietary habits in Denmark 2003–2008 – Main Results (DTU-FOOD, 2010) *(Danskernes Kostvaner 2003–2008* – Hovedresultater). In this survey, dietary data from 4431 individuals aged 4–75 years has been collected through a seven day diary between 2003 and 2008. Table 6.1 presents main results from the Danish survey and Table E.1 in Annex E presents the detailed results.

Table 6.1: Dietary Habits in Denmark 2003–2008

Group (years)	Mean	90th percentiles
Cheese and cheese products (g/day)		
All children 4–9	19	37
All children 10–17	26	52
All adults 18–75	34	65
Total (all)	31	62
Cereals including bread (g/day)		
All children 4–9	199	276
All children 10–17	212	298
All adults 18–75	214	320
Total (all)	212	314
Vegetables exclusive potatoes (g/day)		
All children 4–9	122	207
All children 10–17	131	230
All adults 18–75	162	278
Total (all)	153	265
Potatoes and potato products (g/day)		
All children 4–9	74	139
All children 10–17	95	198
All adults 18–75	112	219
Total (all)	94	189

Group (years)	Mean	90th percentiles
Fruits and fruit products (g/day)		
All children 4–9	260	469
All children 10–17	274	541
All adults 18–75	283	548
Total (all)	280	541
Meat and meat products (g/day)		
All children 4–9	83	126
All children 10–17	97	162
All adults 18–75	109	188
Total (all)	105	179
Poultry and poultry products (g/day)		
All children 4–9	16	37
All children 10–17	22	51
All adults 18–75	23	55
Total (all)	22	53
Fish and fish products (g/day)		
All children 4–9	12	31
All children 10–17	11	28
All adults 18–75	22	47
Total (all)	19	44
Eggs (g/day)		
All children 4–9	13	26
All children 10–17	12	28
All adults 18–75	17	35
Total (all)	16	33
Fats (g/day)		
All children 4–9	33	55
All children 10–17	30	52
All adults 18–75	35	63
Total (all)	34	60
Sugar and candy (g/day)		
All children 4–9	39	67
All children 10–17	42	78
All adults 18–75	34	69
Total (all)	36	70
Energy (MJ/day)		
All children 4–9	8.0	10.6
All children 10–17	8.6	11.6
All adults 18–75	9.1	12.9
Total (all)	8.9	12.5

Source: Modified from *Dietary habits in Denmark 2003–2008 – Main Results,* National Food Institute, Technical University of Denmark, (DTU-FOOD, 2010)

The recommended food consumption rates from the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001) are presented in Table 6.2.

Table 6.2: Recommendations on the Average Food Consumption in the European Community and its Member Countries – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Food	EC	B	DK	F	D	GR	IRL	I	NL	P	SP	UK	Range Max.
Average Food Consumption (kg per capita per year)													
Meat[a]	94.0	105.0	108.9	109.9	104.9	76.4	87.3	87.5	88.8	68.4	95.0	77.3	109.9
Beef and veal	22.0	22.3	18.1	30.7	23.7	19.0	19.0	26.8	19.3	13.6	11.5	17.0	30.7
Pork	40.7	49.1	69.1	37.6	63.2	22.2	34.7	30.8	47.6	25.9	47.4	24.8	69.1
Other	21.7	19.3	13.3	25.2	12.6	29.5	26.7	20.9	18.5	21.9	27.4	25.0	29.5
Fish	10.1	10.2	41.8	7.5	7.4	7.2	12.6	10.1	9.8	24.7	20.3	3.5	41.8
Milk+Yoghurt	82.4	67.8	74.2	65.8	65.8	66.9	173.6	69.7	79.3	52.1	102.6	122.3	173.6
Butter	4.9	8.6	6.9	8.6	8.5	1.0	5.5	2.4	3.9	0.9	0.6	4.2	8.6
Cheese	14.5	12.6	12.8	22.4	17.4	22.1	5.4	17.6	15.0	5.2	5.5	8.0	22.4
Fruit+Vegetables	205.6	173.8	149.8	194.0	196.4	248.3	148.3	277.5	242.5	165.4	252.6	131.6	277.5
Cereals	116.5	98.7	93.1	101.8	99.6	145.2	144.7	160.0	74.5	125.4	97.7	119.6	160.0
Potatoes	83.3	97.6	62.9	73.6	69.6	86.4	140.2	38.0	87.0	111.5	107.0	106.7	140.2
Average Food Consumption in g per kg Body Weight per Day[b]													
Meat[a]	4.4	5.0	5.1	5.2	5.0	3.6	4.1	4.1	4.2	3.2	4.5	3.7	5.2
Beef and veal	1.0	1.1	0.9	1.5	1.1	0.9	0.9	1.3	0.9	0.6	0.5	0.8	1.5
Pork	1.9	2.3	3.3	1.8	3.0	1.0	1.6	1.5	2.2	1.2	2.2	1.2	3.3
Other	1.0	0.9	0.6	1.2	0.6	1.4	1.3	1.0	0.9	1.0	1.3	1.2	1.4
Fish	0.5	0.5	2.0	0.4	0.3	0.3	0.6	0.5	0.5	1.2	1.0	0.2	2.0
Milk+Yoghurt	3.9	3.2	3.5	3.1	3.1	3.2	8.2	3.3	3.7	2.5	4.8	5.8	8.2
Butter	0.2	0.4	0.3	0.4	0.4	0.0	0.3	0.1	0.2	0.0	0.0	0.2	0.4
Cheese	0.7	0.6	0.6	1.1	0.8	1.0	0.3	0.8	0.7	0.2	0.3	0.4	1.1
Fruit+Vegetables	9.7	8.2	7.1	9.2	9.3	11.7	7.0	13.1	11.5	7.8	11.9	6.2	13.1
Cereals	5.5	4.7	4.4	4.8	4.7	6.9	6.8	7.6	3.5	5.9	4.6	5.6	7.6
Potatoes	3.9	4.6	3.0	3.5	3.3	4.1	6.6	1.8	4.1	5.3	5.1	5.0	6.6

a) Total does not reflect the sum of the subgroups.

b) Averages over lifetime assuming average bodyweight of 58 kg (Table 1 values divided by 58 kg and 365 days/year).

Source: ECETOC, 1994 citation of Euromonitor 1992, European Marketing Data and Statistics, modified from ECETOC, 2001.

According to the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), the recommendations for breast milk intake are the same as presented in the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997). No UK studies were cited in US-EPA (1997), but breast milk consumption values for Swedish infants were similar to those of US infants. The data from US-EPA (1997), is presented in Table 6.3.

Table 6.3: Standard Breast Milk Intake Rates – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Age	Mean (ml/day)	Upper percentile (mean + 2 SD)
1–6 months	742	1033
12 months	688	980

Source: US-EPA, 1997, modified from ECETOC, 2001.

6.2 US-EPA

In the *Exposure Factors Handbook* (US-EPA, 2009), recommendations on intake of food are divided into different food categories: Fruits and Vegetables, Fish, Meats, Dairy and Fats, Grains, Total food intake, and Human Breast Milk and Lipids.

6.2.1 Fruits and Vegetables

The US-EPA analysis of data from the 1994–96 and 1998 Continuing Survey of Food Intake by Individuals (CSFII) was used in selecting recommended intake rates for the general population and children in the *Exposure Factors Handbook* (US-EPA, 2009). Table 6.4 presents a summary of the recommended values for per capita and consumer-only intake of fruits and vegetables, on an as-consumed basis. Total fruit intake refers to the sum of all fruits consumed in a day including canned, dried, frozen, and fresh fruits. Likewise, total vegetable intake refers to the sum of all vegetables consumed in a day including canned, dried, frozen, and fresh vegetables.

The US-EPA recommended values presented in Table 6.4 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – high, 2. applicability and utility – medium, 3. clarity and completeness – high, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was medium-high. (US-EPA, 2009).

Table 6.4: Recommended Values for Intake of Fruits and Vegetables, As Consumed – as Presented in the Exposure Factors Handbook

Age (Years)	Total Fruits (g/kg-day)				Total Vegetables (g/kg-day)			
	Per Capita		Consumers Only		Per Capita		Consumers Only	
	Mean	95th	Mean	95th	Mean	95th	Mean	95th
0–1	5.7	21.3	10.1	26.4	4.5	14.8	6.2	16.1
1–<2	6.2	18.5	6.9	19.0	6.9	17.1	6.9	17.1
2–<3	6.2	18.5	6.9	19.0	6.9	17.1	6.9	17.1
3–<6	4.6	14.4	5.1	15.0	5.9	14.7	5.9	14.7
6–<11	2.4	8.8	2.7	9.3	4.1	9.9	4.1	9.9
11–<16	0.8	3.5	1.1	3.7	2.9	6.9	2.9	6.9
16–<21	0.8	3.5	1.1	3.7	2.9	6.9	2.9	6.9
20–<50	0.9	3.9	1.2	4.4	2.9	6.8	2.9	6.8
≥50	1.4	4.8	1.6	5.0	3.1	7.0	3.1	7.0

Source: US-EPA Analysis of CSFII, 1994–96 and 1998, based on USDA, 2000 and US-EPA, 2000, modified from US-EPA, 2009

6.2.2 Fish

Due to considerable variation in the studies presented in the *Exposure Factors Handbook* (US-EPA, 2009), fish consumption studies were classified into the following categories:

- General Population (total, marine, freshwater/estuarine)
- Recreational Marine Intake

The key study identified in the *Exposure Factors Handbook* (US-EPA, 2009) for mean fish intake among the general population is based on a US-EPA (2002) analysis of data from the US Department of Agriculture (USDA) Continuing Survey of Food Intake among Individuals (CSFII) 1994–1996, 1998 (USDA, 2000). Data from this key study is presented in Table 6.5.

The US-EPA recommended values presented in Table 6.5 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium, 2. applicability and utility – medium, 3. clarity and completeness – high, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was medium. (US-EPA, 2009).

Table 6.5: Recommended Values for General Population and Recreational Population Fish Intake – as Presented in the Exposure Factors Handbook

Age (Years)	Per Capita				Consumers Only			
	Mean		95th Percentile		Mean		95th Percentile	
	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day	g/day	g/kg-day
General Population – Total Fish[a]								
3–<6	7.7	0.43	51.0	3.0	74	4.2	184	10
6–<11	8.5	0.28	56.4	1.9	95	3.2	313	8.7
11–<16	12.0	0.23	87.4	1.5	113	2.2	308	6.2
16–<18	10.6	0.16	83.5	1.3	136	2.1	357	6.6
>18	19.9	0.27	111.3	1.5	127	1.8	334	4.5
General Population – Marine Fish[a]								
3–<6	5.5	0.31	39.4	2.3	66	3.7	165	9.3
6–<11	5.6	0.20	38.4	1.5	78	2.8	202	8.0
11–<16	7.6	0.15	56.5	1.3	102	2.0	262	5.2
16–<18	6.1	0.10	29.5	0.5	126	2.0	353	6.5
>18	12.4	0.17	80.7	1.1	108	1.5	270	3.7
General Population – Freshwater/Estuarine Fish[a]								
3–<6	2.2	0.12	12.2	0.7	40	2.3	129	7.2
6–<11	3.0	0.08	13.1	0.4	61	1.8	248	6.2
11–<16	4.3	0.08	25.8	0.5	71	1.3	199	4.4
16–<18	4.6	0.07	19.3	0.3	100	1.4	242	3.3
>18	7.5	0.10	49.6	0.7	81	1.1	279	3.7
Recreational Population – Marine Fish – Atlantic								
3–<6	2.5		8.2					
6–<11	2.5		9.1					
11–<16	3.4		14.1					
16–<18	2.8		13.5					
>18	5.6		18.0					
Recreational Population – Marine Fish – Gulf								
3–<6	3.2		12.0					
6–<11	3.3		13.2					
11–<16	4.4		20.5					
16–<18	3.5		19.6					
>18	7.2		26.1					
Recreational Population – Marine Fish – Pacific								
3–<6	0.9		3.1					
6–<11	0.9		3.4					
11–<16	1.2		5.3					
16–<18	1.0		5.1					
>18	2.0		6.8					

a) Rates are for uncooked fish.

Source: US-EPA, 2002 and US-EPA analysis of NMFS, 1993, modified from US-EPA, 2009.

6.2.3 Meats, Dairy Products and Fats

In the *Exposure Factors Handbook* (US-EPA, 2009), US-EPA analyses of data from the 1994–96 and 1998 CSFII (USDA, 2000) were used in selecting recommended intake rates for the general population. Table 6.6 presents a summary of the recommended values for per capita and consumers-only intake of meats, dairy products, and fats, on an as-consumed basis.

The US-EPA recommended values presented in Table 6.6 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence

ratings for the five GAFs: 1. Soundness – high, 2. applicability and utility – medium, 3. clarity and completeness – high, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was high. (US-EPA, 2009).

Table 6.6: Recommended Values for Intake of Meats, Dairy Products and Fats, As Consumed – as Presented in the Exposure Factors Handbook

Age	Total Meats (g/kg-day)				Total Dairy Products (g/kg-day)				Total Fats (g/kg-day)			
	Per Capita		Consumers		Per Capita		Consumers		Per Capita		Consumers	
	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th	Mean	95th
0–<1 m									5.2	16	7.8	16
1–<3 m									4.5	11	6.0	12
3–6 <m									4.1	8.2	4.4	8.3
6–12 <m									3.7	7.0	3.7	7.0
0–1 y	1.2	6.7	3.0	9.2	12.6	48.7	15.9	57.5				
1–<2 y	4.1	9.8	4.2	9.8	36.7	88.3	36.8	88.3	4.0	7.1	4.0	7.1
2–<3 y	4.1	9.8	4.2	9.8	36.7	88.3	36.8	88.3	3.6	6.4	3.6	6.4
3–<6 y	4.1	9.4	4.2	9.4	23.3	49.4	23.3	49.4	3.4	5.8	3.4	5.8
6–<11 y	2.9	6.5	2.9	6.5	13.6	31.5	13.6	31.5	2.6	4.2	2.6	4.2
11–<16 y	2.1	4.8	2.1	4.8	5.6	15.5	5.6	15.5	1.6	3.0	1.6	3.0
16–<21 y	2.1	4.8	2.1	4.8	5.6	15.5	5.6	15.5	1.3	2.7	1.3	2.7
21–<31 y									1.2	2.3	1.2	2.3
31–<41 y									1.1	2.1	1.1	2.1
41–<51 y									1.0	1.9	1.0	1.9
20–<50 y	1.9	4.2	1.9	4.2	3.3	9.9	3.3	9.9				
≥50 y	1.5	3.3	1.5	3.3	3.2	8.9	3.2	8.9				
51–<61 y									0.9	1.7	0.9	1.7
61–<71 y									0.9	1.7	0.9	1.7
71–<81 y									0.8	1.5	0.8	1.5
≥81 y									0.9	1.5	0.9	1.5

Source: US-EPA analysis of CSFII, 1994–96 and 1998, based on USDA, 2000 and US-EPA, 2000 and 2007b, modified from US-EPA, 2009.

6.2.4 Grains

The US-EPA analyses of data from the 1994–96 and 1998 CSFII were used in selecting recommended intake rates of grains for the general population in the *Exposure Factors Handbook* (US-EPA, 2009). Table 6.7 presents a summary of the recommended values for per capita and consumer-only intake of grain products, on an as-consumed basis.

The US-EPA recommended values presented in Table 6.7 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – high, 2. applicability and utility – medium, 3. clarity and completeness – high, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was medium-high. (US-EPA, 2009).

Table 6.7: Recommended Values for Intake of Grains, As Consumed – as Presented in the Exposure Factors Handbook

Age (year)	Per Capita		Consumers Only	
	Mean (g/kg-day)	95th (g/kg-day)	Mean (g/kg-day)	95th (g/kg-day)
0–1	2.5	8.6	3.6	9.2
1–<2	6.4	12	6.4	12
2–<3	6.4	12	6.4	12
3–<6	6.3	12	6.3	12
6–<11	4.3	8.2	4.3	8.2
11–<16	2.5	5.1	2.5	5.1
16–<21	2.5	5.1	2.5	5.1
20–<50	2.2	4.7	2.2	4.7
≥50	1.7	3.5	1.7	3.5

Source: US-EPA Analysis of CSFII, 1994–96 and 1998, based on USDA, 2000 and US-EPA, 2000, modified from US-EPA, 2009.

6.2.5 Total Food Intake

A summary of recommended values for total food intake, on an as-consumed basis from the *Exposure Factors Handbook* (US-EPA, 2009), is presented in Table 6.8. The recommended intake rates are based on data from the US-EPA (2007b) analysis of CSFII data.

The US-EPA recommended values presented in Table 6.8 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – high, 2. applicability and utility – medium, 3. clarity and completeness – medium, 4. variability and uncertainty – medium, and 5. evaluation and review – medium; the overall rating was medium. (US-EPA, 2009).

Table 6.8: Recommended Values for Per Capita Total Food Intake, As Consumed – as Presented in the Exposure Factors Handbook

Age Group	Mean (g/kg-day)	95th Percentile (g/kg-day)
Children		
0–1 month	20	61
1–<3 months	16	40
3–<6 months	28	65
6–<12 months	56	134
1–<2 years	90	161
2–<3 years	74	126
3–<6 years	61	102
6–<11 years	40	70
11–<16 years	24	45
16–<21 years	18	35
Adults		
20–<40 years	16	30
40–<70 years	14	26
≥70 years	15	27

Note: Total food intake was defined as intake of the sum of all foods in the following major food categories: dairy, meats, fish, eggs, grains, vegetables, fruits, and fats. Beverages, sugar, candy, and sweets, and nuts and nut products were not included because they could not be categorized into the major food groups. Also, human milk intake was not included.

Source: US EPA re-analysis of CSFII 1994–96, 98 data (Based on US EPA, 2007b), modified from US-EPA, 2009.

6.2.6 Human Breast Milk and Lipids

According to the *Exposure Factors Handbook* (US-EPA, 2009), among infants born in 2004, 73.8% were breastfed postpartum, 41.5% at 6 months, and 20.9% at 12 months.

Seven key studies were identified which gave rise to the recommended values for human milk and lipid intake as presented in Table 6.9. These key studies among nursing mothers in industrialized countries have shown that average intakes among infants ranged from approximately 500 to 800 ml/day, with the highest intake reported for infants 3 to below 6 months old. It should be noted that the decrease in human milk intake with age is likely a result of complementary foods being introduced as the child grows and not necessarily a decrease in total energy intake. Recommendations were converted to ml/day using a density of human milk of 1.03 g/ml rounded up to two significant figures (US-EPA, 2009).

The US-EPA recommended values presented in Table 6.9 are well validated as the general assessment factors (GAFs, described in Section 1.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium, 2. applicability and utility – medium, 3. clarity and completeness – medium, 4. variability and uncertainty – low, and 5. evaluation and review – high; the overall rating was medium. (US-EPA, 2009).

Table 6.9: Recommended Values for Human Breast Milk and Lipid Intake Rates for Exclusively Breastfed Infant – as Presented in the Exposure Factors Handbook

Age (months)	Human Milk Intake				Lipid Intake[a]			
	Mean		95th Percentile[b]		Mean		95th Percentile[b]	
	ml/day	ml/kg-day	ml/day	ml/kg-day	ml/day	ml/kg-day	ml/day	ml/kg-day
0–<1	510	150	950	220	20	6.0	38	8.7
1–<3	690	140	980	190	27	5.0	40	8.0
3–<6	770	110	1,000	150	30	4.2	42	6.1
6–<12	620	83	1,000	130	25	3.3	42	5.2

a) The recommended value for lipid content of human milk is 4.0 percent.

b) Upper percentile is reported as mean plus 2 standard deviations.

Source: Neville et al., 1988, Pao et al., 1980, Butte et al., 1984, Dewey and Lönnerdal, 1983, Butte et al., 2000, Dewey et al., 1991b and Arcus-Arth et al., 2005, modified from US-EPA, 2009.

Note: All references are cited in US-EPA, 2009.

6.3 WHO

The WHO standard values for food intake are those recommended by the ICRP (ICRP, 1974, cited in WHO/IPCS, 1994 and 1999). These values are presented in Table 6.10.

Table 6.10: WHO's Standard Values on Dietary Intake

Food	Daily Intake in g per Day[a]
Cereals	323 (flour and milled rice)
Starchy Roots	225 (sweet potatoes, cassava and other)
Sugar	72 (includes raw sugar, excludes syrups and honey)
Pulses and Nuts	33 (includes cocoa beans)
Vegetables and Fruits	325 (fresh equivalent)
Meat	125 (includes offal, poultry and game in terms of carcass weight, excluding slaughter fats)
Eggs	19 (fresh equivalent)
Fish	23 (landed weight)
Milk	360 (excludes butter; includes milk products as fresh milk equivalent)
Fats and Oils	31 (pure fat content)

a) Based on average of estimates for seven geographical regions.

Source: Modified from WHO/IPCS, 1994.

6.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) as well as the European data are comprehensive, whereas the WHO data are limited.

In the REACH TGD Chapter R8 (ECHA, 2008a), the recommended values are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommendations are taken from one of these references or both. The recommended food consumption rates from ECETOC (ECETOC, 2001) are based on European data published in 1992. The Danish survey on dietary habits (DTU-FOOD, 2010) has been performed in the period 2003–2008. The recommended standard breast milk intake rates from ECETOC (ECETOC, 2001) are taken from the 1997 version of the *Exposure Factors Handbook* (US-EPA, 1997).

The US-EPA recommended values for food intake are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. In general, the US-EPA overall ratings were medium to high.

The WHO standard values on dietary intake (Table 6.10) are those recommended by the ICRP (ICRP, 1974).

It should be noted that the references "ICRP, 1974" and "ICRP, 1975" are to the same ICRP report (ICRP Report No. 23).

The US-EPA recommendations as well as the Danish data on dietary habits are considered as being the most valid values for food consumption rates today as these recommendations are based on analyses of the most recent data. The Danish data are considered as being more representative for Europeans in general.

There might be some differences between US and European infants regarding breast milk intake. However, according to ECETOC (ECETOC, 2001), breast milk consumption values for Swedish infants were similar to those of US infants. Thus, the more recent US-EPA recommendations (US-EPA, 2009) are considered as being representative for European infants as well.

In conclusion, the Danish data on dietary habits presented in Table 6.1 are considered as being the most valid values for food consumption rates and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH. For breast milk intake, the US-EPA recommendations presented in Table 6.9 are considered as being the most valid values today and are therefore recommended as default exposure factors for assessments of European infants in the context of REACH.

The recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides etc.

7. Soil and Dust Ingestion and Inhalation

The ingestion of soil is a potential source of human exposure to chemical substances. The exposure is usually expressed as an average amount of soil ingested per unit time (e.g., mg/day).

The potential for exposure to contaminants via soil is greater for small children because they are naturally curious and often examine new objects by putting them into their mouth; this mouthing behaviour is considered to be a normal phase of childhood development. In addition to ingestion of soil through the mouthing of objects or hands, true eating of soil (geophagy) is also a source of oral exposure to chemicals for children. Furthermore, children tend to play on the ground and on the floor, which also may lead to an increased exposure to chemicals in soil and dust particles when compared to adults. Soil ingestion among children may be uneven as most children only ingest relatively small amounts, while a few children may consume larger amounts. Deliberate ingestion of larger amounts of soil is termed "pica" (pica, which is the Latin word for the magpie, refers to "*the persistent eating of non-nutritive substances*"). Adults may also ingest soil and dust particles that adhere to food, cigarettes, or their hands thereby being exposed to contaminants in soil and dust particles.

There are several methodologies presented in the literature related to soil and dust ingestion (US-EPA, 2009). Three methodologies combine biomarker measurements with measurements of the biomarker substance's presence in environmental media. The "tracer element" method measures quantities of specific elements present in faeces, urine, food and medications, yard soil, house dust, and sometimes also community soil and dust, and combines this information using certain assumptions about the elements' behaviour in the gastrointestinal tract to produce estimates of soil and dust quantities ingested. The "bio-kinetic model comparison" methodology compares results from a bio-kinetic model of lead exposure and uptake that predict blood lead levels, with biomarker measurements of lead in blood. The "lead isotope ratio" methodology involves measurements of different lead isotopes in blood and/or urine, food, water, and house dust and compares the ratio of different lead isotopes to infer sources of lead exposure that may include dust or other environmental exposures. A fourth methodology, the "survey response" methodology, offers indirect evidence of soil/dust ingestion behaviours where responses to survey questions regarding soil and dust ingestion of adults, caregivers, and/or children are analysed.

7.1 Europe

In the *Exposure to chemicals via house dust* (RIVM, 2008), values for ingestion and inhalation of house dust is provided. Table 7.1 presents the default values, which have been based on several studies. In section 11.2.6, Table 11.3, intake of dust from chalk is presented.

Table 7.1: Default Values for House Dust Ingestion and Inhalation

	Ingestion of House Dust (mg/day)	Inhalation of House Dust (mg/day)	Total Intake of House Dust (mg/day)
Adult	50	0.8	50
Child	100	2.0	100

Source: RIVM, 2008.

The Danish Environmental Protection Agency (D-EPA) has in their *Guidance from the Environmental Protection Agency No. 5* (D-EPA, 2006) recommended values for intakes of soil as presented in Table 7.2. The recommendations are based on the 1997 version of the EFH (US-EPA, 1997).

Table 7.2: Recommended Values for Intake of Soil – as Presented in Guidance from the Danish Environmental Protection Agency No. 5, 2006.

Route of Exposure	Default Value
Oral, maximum single intake	10 g
Oral, mean daily intake	0.1 g/day
Oral, 95th percentile	0.2 g/day
Dermal contact, mean daily	1 g/day
Dermal contact, maximum	10 g/day

Source: D-EPA, 2006.

In the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), median soil ingestion rates have been estimated as 40 mg/day and 1 mg/day for children and adults, respectively. The data were based upon US studies (Calabrese et al., 1997 and Stanek et al., 1997), but represented the best available information according to ECETOC (2001). Upper limits for soil ingestion of 200 mg/day for children and 300 mg/day for adults were considered to be supported by the available data. ECETOC has noted that the higher upper limit for adults is related to data variability and indicates the uncertainty in current estimates. It was also noted that the recommended values were based upon studies performed in the summer or autumn and that soil ingestion during winter is likely lower.

7.2 US-EPA

In the Exposure Factors Handbook (EFH) (US-EPA, 2009), nine "key studies" and 28 "relevant studies" were identified. The key studies were used to recommend values for soil and dust ingestion for adults and children. The US-EPA has noted that studies estimating adult soil ingestion were extremely limited, and only two of these were considered to be key studies. Furthermore, there were no available studies estimating the ingestion of dust by adults and therefore, no recommended values were provided for adults for either dust or soil + dust ingestion. The US-EPA has also noted that the key studies pre-dated the recommendations on age groups in the US-EPA's Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (US-EPA 2005), and were performed on groups of children of varying ages.

Table 7.3 presents the central tendency recommendations for daily ingestion of soil, dust, or soil + dust, in mg/day and rounded to one significant figure. The soil ingestion recommendations represent ingestion of a combination of soil and outdoor settled dust, without distinguishing between these two sources. The dust ingestion recommendations include soil tracked into the indoor setting, indoor settled dust and air-suspended particulate matter that is inhaled and swallowed. The soil + dust recommendations are the sum of the soil and dust recommendations. The recommended values represent mass of ingested soil or dust on a dry weight basis. A summary of the nine key studies is presented in Table F.1 in Annex F.

Table 7.3 also presents the soil-pica or geophagy recommendations for daily ingestion of soil, in mg/day. No data were available on which to base comparable upper percentile recommendations for dust or soil + dust for adults or children. The US-EPA has noted that, due to the current state of research on soil and dust ingestion, the upper percentile recommendations are called "soil-pica" (the recurrent ingestion of unusually high amounts of soil, i.e., on the order of 1000-5000 mg/day or more) or "geophagy" (the intentional ingestion of earths, usually associated with cultural practises) recommendations that are likely to represent high soil ingestion episodes or behaviours at an unknown point on the high end of the distribution of soil ingestion.

Table 7.3: Recommendation for Soil and Dust Ingestion – as Presented in the Exposure Factors Handbook

Age	Soil[a]			Dust[b]	Soil and Dust
		Upper Percentile			
	Central Tendency mg/day	Soil-Pica mg/day	Geophagy mg/day	Central Tendency mg/day	Central Tendency mg/day
6–<12 months	30	-	-	30	60
1–<6 years	50	1,000	50,000	60	100[c]
6–<21 years	50	1,000	50,000	60	100[c]
Adult	50	-	50,000	-	-

-) No recommendation.

a) Includes soil and outdoor settled dust.

b) Includes indoor settled dust only.

c) Total soil and dust ingestion rate is 110 mg/day; rounded to one significant figure it is 100 mg/day.

Source: Modified from US-EPA, 2009.

The US-EPA recommended values for intake of soil and presented in Table 7.3 are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – low, 2. applicability and utility – low, 3. clarity and completeness – low, 4. variability and uncertainty – low, and 5. evaluation and review – medium; the overall rating was low. (US-EPA, 2009).

7.3 WHO

WHO (WHO, 1994) has specified the daily amount of soil ingested as 20 mg/day. This is a median value from the national Department of Health of the Government of Canada (Health and Welfare Canada, 1992). It has not been specified whether this standard value is valid for adults or for children.

7.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. There are some European data, but the WHO data are limited.

The Danish Environmental Protection Agency (D-EPA, 2006) has based their recommended values on the 1997 version of the EFH (US-EPA, 1997).

The recommendations from ECETOC (ECETOC, 2001) are based upon two US studies. The recommendation for children is based on a study on children residing on a grassy Superfund site (Calabrese et al., 1997), included in the 2009 version of the EFH (US-EPA, 2009) as one of the nine key studies. According to ECETOC, it is possible that the physical

nature of the site and possible changes in activity patterns associated with Superfund designation could have led to a depression in soil ingestion rates in this study. The recommendation for adults is based on a pilot study (Stanek et al., 1997); this study is not included in the 2009 version of the EFH (US-EPA, 2009).

The US-EPA recommended values for intake of soil (presented in Table 7.3) are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA overall rating was low. (US-EPA, 2009).

The WHO standard value on soil ingestion is a median value from the national Department of Health of the Government of Canada (Health and Welfare Canada, 1992). It has not been specified whether this standard value is valid for adults or for children.

Data on soil and dust ingestion rates are generally limited and variable, and region specific differences in child play and hygienic patterns will likely affect typical soil and dust ingestion rates. Thus, there might be some differences between the US and European population regarding soil and dust ingestion. Even though the US-EPA recommendations are considered as being the most valid values for soil and dust ingestion rates, the recommended values for house dust ingestion and inhalation rates for adults and children from RIVM (RIVM 2008) are considered as being representative for the European population. For children's dust ingestion the ECHA Guidance on information recuiremments and chemical safety assessment, Chapter R.15: Consumer exposure estimation (ECHA 2008b) also refer to the Dutch data. In conclusion, the RIVM recommended values wich are also referred in ECHA's REACH guidance R15, are presented in Table 7.1 and are considered as being the most valid values for dust ingestion rates in Europe as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

8. Non-Dietary Ingestion Factors

Adults and children have the potential for exposure to toxic substances through non-dietary ingestion pathways other than soil and dust ingestion, e.g., ingesting pesticide residues that have been transferred from treated surfaces to the hands or objects that are mouthed. Adult's mouth objects such as cigarettes, pens/pencils, or their hands. Young children mouth objects, surfaces or their fingers as they explore their environment. Mouthing behaviour includes all activities in which objects, including fingers, are touched by the mouth or put into the mouth except for eating and drinking, and includes licking, sucking, chewing, and biting (US-EPA, 2009).

8.1 Europe

In the *Children's Toys Fact Sheet* (RIVM, 2002), default values of hand-to-mouth contact and direct ingestion are presented. As these values are based on various sorts of toys, they are described in the section on Consumer Products (Section 11.2.6).

In the *Preparation of a Guidance Document on Pesticide Exposure; Assessment for Workers, Operators, Bystanders and Residents* (EFSA, 2010), the default value for hand-to-mouth activity for children is set to 9.5 events per hour with a surface area of 20 cm^2 of the mouthed hands.

8.2 US-EPA

In the Exposure Factors Handbook (EFH) (US-EPA, 2009) nine "key studies" and four "relevant studies" were identified regarding mouthing frequency, and three "key studies" and five "relevant studies" were identified regarding mouthing duration. The key studies were used to develop recommended values for mouthing frequency and duration, respectively, among children. No studies were located that provided data on mouthing frequency or duration for adults. US-EPA has noted that, in several cases, the key studies predated the recommendations on age groups in the US-EPA's Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants (US-EPA 2005), and were performed on groups of children of varying ages. In the cases in which age groups of children in the key studies did not correspond exactly to the US-EPA's recommended age groups, the closest age group was used.

Table 8.1 presents the recommended mouthing frequencies, expressed in units of contacts per hour, between either an object or surface and the

mouth (object-to-mouth), or between any part of the hand (including fingers and thumbs) and the mouth (hand-to-mouth). The recommended hand-to-mouth frequencies are based on data from a recent study (Xue et al., 2007, cited in US-EPA, 2009) in which a secondary analysis of data from several of the studies summarized in the EFH, as well as data from unpublished studies, was conducted. The recommended object-to-mouth frequencies are based on data from a very recent study (Xue et al., 2009, cited in US-EPA, 2009) in which a secondary analysis of data from several of the studies summarized in the EFH was conducted. Recommendations for duration of object-to-mouth contacts are based on data from the three key studies. Recommendations for hand-to-mouth duration are not provided in the EFH since it was considered that those estimates may not be relevant to environmental exposures. (US-EPA, 2009).

Table 8.1: Recommendations on Mouthing Frequency and Duration among Children – as Presented in the Exposure Factors Handbook

Age	Object-to-mouth					
	Indoor frequency		Outdoor frequency		Duration	
	Mean contacts/hr	95th Percentile contacts/hr	Mean contacts/hr	95th Percentile contacts/hr	Mean contacts/hr	95th Percentile contacts/hr
0–1 months	-	-	-	-	-	-
1–<3 months	-	-	-	-	-	-
3–<6 months	11	32	-	-	11	26
6–<12 months	28	84	-	-	9	19
1–<2 years	27	82	8.8	21	7	22
2–<3 years	15	36	8.1	40	10	11
3–<6 years	10	39	8.3	30	-	-
6–<11 years	1.3	3.7	1.9	9.1	-	-
11–<16 years	-	-	-	-	-	-
16–<21 years	-	-	-	-	-	-

Age	Hand-to-mouth			
	Indoor frequency		Outdoor frequency	
	Mean cotacts/hr	95th Percentile contacts/hr	Mean contacts/hr	95th Percentile contacts/hr
0–1 months	-	-	-	-
1–<3 months	-	-	-	-
3–<6 months	28	65	-	-
6–<12 months	19	52	15	47
1–<2 years	20	63	14	42
2–<3 years	13	37	5	20
3–<6 years	15	54	9	36
6–<11 years	7	21	3	12
11–<16 years	-	-	-	-
16–<21 years	-	-	-	-

Sources: "Hand-to-mouth" frequencies: Xue et al., 2007. "Object-to-mouth" frequencies: Xue et al., 2009. "Mouthing duration": Juberg et al., 2001; Greene et al., 2002 and Beamer et al., 2008, modified from US-EPA, 2009.

Note: All references are cited in US-EPA, 2009.

The US-EPA recommended values for non-dietary ingestion factors presented in Table 8.1 are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has

assigned the following confidence ratings for the five GAFs: 1. Soundness – low, 2. applicability and utility – low, 3. clarity and completeness – low, 4. variability and uncertainty – low, and 5. evaluation and review – medium; the overall rating was low for both frequency and duration of hand-to-mouth and object-to-mouth. (US-EPA, 2009).

8.3 WHO

No recommendations on non-dietary ingestion factors are provided by the WHO.

8.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited to single values for specific assessment purposes. No recommendations have been provided by the WHO.

There are no references provided for the recommended value for hand-to-mouth activity for children from EFSA (EFSA, 2008).

The US-EPA recommended values for non-dietary ingestion factors presented in Table 8.1 are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA overall rating was low for both frequency and duration of hand-to-mouth and object-to-mouth. (US-EPA, 2009).

There might be some differences between US and European children regarding hand-to-mouth and hand-to-object frequency and duration. Despite this, the US-EPA recommended values are considered as being representative for European children as well. Furthermore, the US-EPA recommendations are considered as being the most valid values for non-dietary ingestion factors as today despite the overall rating as low, as these recommendations are based on relatively recent key studies published in the period 2001–2008.

In conclusion, the US-EPA recommended values presented in Table 8.1 are considered as being the most valid values for non-dietary ingestion factors as today and are therefore recommended as default exposure factors for assessments of European children in the context of REACH. No studies have been located on mouthing frequency or duration for adults and therefore, no default exposure factors can be recommended.

9. Lifetime Expectancy

The length of an individual's life is an important factor to consider when evaluating cancer risk because the dose estimate is averaged over an individual's lifetime. Since the averaging time is found in the denominator of the dose equation, a shorter lifetime would result in a higher potential risk estimate, and conversely, a longer life expectancy would produce a lower potential risk estimate. (US-EPA, 2009).

9.1 Europe

In the *REACH Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a), the recommended lifespan is 75 years for exposure assessments of consumers and man exposed indirectly via the environment.

According to the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001), the average life expectancy of a UK child born in 1998 is 78 years. Life expectancies for European countries are presented in Annex G, Table G.1 and recent statistics on life expectancy for England are provided presented by sex in Table G.2.

9.2 US-EPA

According to the *Exposure Factors Handbook* (US-EPA, 2009), current data suggest that 78 year is an appropriate value to reflect the average life expectancy of the general population and is therefore the recommended value. It should be noted, that if gender is a factor considered in the assessment, the average life expectancy value for females is higher than for males. It is recommended that the assessor use the appropriate value of 75 years for males or 80 years for females, based on life expectancy data from 2005 (US National Centre for Health Statistics, 2008). Table 9.1 presents recommended values for life expectancy at birth.

The US-EPA recommended values for lifetime expectancy are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness – medium to high, 2. applicability and utility – high, 3. clarity and completeness – high, 4. variability and uncertainty – medium, and 5. evaluation and review – high. The overall rating was high.

Table 9.1: Recommended Values for Expectation of Life at Birth: 2005 – as Presented in the Exposure Factors Handbook

Population	Life Expectancy (years)
Men	75
Women	80
Total	78

Source: US National Centre for Health Statistics, 2008; modified from US-EPA, 2009

9.3 WHO

WHO has estimated worldwide life expectancy at birth for the year 2008 (WHO, 2010). Table 9.2 presents life expectancy at birth for all European countries combined and global. In Annex F, Table F.3., life expectancy at birth for all European countries in 2008, is presented.

Table 9.2: Life Expectancy at Birth for the European Countries and Global, WHO 2008

Population	Life Expectancy (years)
European Region	
Men	71
Women	79
Men and women	75
Global	
Men	66
Women	70
Men and women	68

Source: WHO, 2010.

9.4 Conclusion and Recommendations

In the REACH TGD Chapter R8 (ECHA, 2008a), the recommended values are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommendations are taken from one of these references or both. The recommendation from ECETOC is based on a WHO report from 1999.

The US-EPA recommended values for lifetime expectancy are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA overall rating was high.

The WHO standard values are from very recent statistics published in 2010.

Life expectancy is very different for various countries in the World. The very recent data published by the WHO in 2010 are considered as being the most representative for European lifetime expectancy as today.

In conclusion, the WHO recommended values for the European Region presented in Table 9.2 are considered as being the most valid values for lifetime expectancy as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

10. Activity Factors

Individual or group activities are important determinants of potential exposure, because toxic chemicals introduced into the environment may not cause harm to an individual until an activity is performed that subjects the individual to contact with those contaminants. An activity or time spent in a given activity will vary among individuals on the basis of, for example, culture, ethnicity, hobbies, location, gender, age, socioeconomic characteristics, and personal preferences. (US-EPA, 2009).

10.1 Europe

In the *REACH Guidance on information requirements and chemical safety assessment Chapter R8* (ECHA, 2008a), the recommended length of a workday is set to 8 hours, working days per week are 5, working weeks per year are recommended to 48 weeks, and worklife is 40 years.

Table 10.1. presents recommended values for activity factors for UK adults and children according to the *Exposure Factors Sourcebook for European Populations, with Focus on UK Data* (ECETOC, 2001).

Table 10.1: Standard Values for Activity Factors for UK Adults and Children – as Presented in the Exposure Factors Sourcebook for European Populations, with Focus on UK Data

Activity Scenario	Mean/Median Time Spent
Work Hours per Week	38[a] hours/day
Indoors (Adults)	22 hours/day
Outdoors (Adults)	2 hours/day
School Day for Children	7[b] hours/day (for 190 day per year)
Indoors	5 hours/day
Outdoors	2 hours/day
Time Spent at Home	
For Full-Time Workers	15 hours/day (14 indoors, 1 outdoors)
For individuals not employed outside of the home	20.5 hours/day (18.5 indoors, 2 outdoors)
Time Spent Away	
For Full-Time Workers	9 hours/day
For individuals not employed outside of the home	3.5 hours/day
Outdoor Recreation (for Adults)	0.3 hours/day (for 365 day per year)
Employment Tenure[c]	8 years
Residential Tenure	9 years
School Tenure	7 years primary school 5 years secondary school

a) Based upon the assumption of 6 weeks for combined vacation and leave, an estimate of ~230 work days/year (46 weeks at 5 days/week) is obtained.

b) For secondary school children involved in extracurricular activities, a value of 8 hours/day may be more representative.

c) Time spent working for current employer.

Source: Modified from ECETOC, 2001.

10.2 US-EPA

In the *Exposure Factors Handbook* (US-EPA, 2009), recommended standard values for activity factors are based on different key studies and values for various scenarios are presented in Table 10.2.

The values presented in Table 10.2 are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA has assigned the following confidence ratings for the five GAFs: 1. Soundness –high, 2. applicability and utility – medium, 3. clarity and completeness – medium, 4. variability and uncertainty – medium, and 5. evaluation and review – medium. The overall rating was medium for the mean and low for upper percentile.

Table 10.2: Recommended Values for Activity Patterns – as Presented in the Exposure Factors Handbook

Age group	Mean	95th Percentile	Reference
Time Indoors (Total) in minutes per day			
0–1 month	1,440	-	
1–<3 months	1,432	-	
3–<6 months	1,414	-	US-EPA analysis of source data from Wiley et
6–<12 months	1,301	-	al., 1991 for age groups from birth to < 12
1–<2 years	1,353	-	months.
2–<3 years	1,316	-	
3–<6 years	1,278	-	
6–<11 years	1,244	-	US-EPA re-analysis of source data from US-EPA,
11–<16 years	1,260	-	1996 for age groups from 1 to < 21 years.
16–<21 years	1,248	-	
18–<65 years	1,159	-	
≥65 years	1,142	-	Adults, ≥ 18 years: US-EPA, 1996.
Time Outdoors (Total) in minutes per day			
0–1 month	0	-	
1–<3 months	8	-	
3–<6 months	26	-	Children, Birth to < 12 months: US-EPA analysis
6–<12 months	139	-	of source data from Wiley et al., 1991.
1–<2 years	36	-	
2–<3 years	76	-	
3–<6 years	107	-	Children, 1 to <21 years: US-EPA re-analysis of
6–<11 years	132	-	source data from US-EPA, 1996.
11–<16 years	100	-	
16–<21 years	102	-	
18–<65 years	281	-	Adults, ≥ 18 years: US-EPA, 1996.
≥65 years	298	-	
Time Indoors (at Residence) in minutes per day			
0–<1 year	1,108	1,440	
1–<2 years	1,065	1,440	
2–<3 years	979	1,296	Children, Birth to <21 years: US-EPA re-analysis
3–<6 years	957	1,355	of source data from US-EPA, 1996.
6–<11 years	893	1,275	
11–<16 years	889	1,315	
16–<21 years	833	1,288	Adults ≥ 18 years: US-EPA, 1996.
18–<65 years	948	1,428	
≥65 years	1,175	1,440	
Showering in minutes per day			
0–<1 year	15	-	
1–<2 years	20	-	
2–<3 years	22	44	US-EPA re-analysis of source data from
3–<6 years	17	34	US-EPA, 1996.
6–<11 years	18	41	
11–<16 years	18	40	
16–<21 years	20	45	

Age group	Mean	95th Percentile	Reference
Bathing in minutes per day			
0–<1 year	19	30	
1–<2 years	23	32	
2–<3 years	23	45	US-EPA re-analysis of source data from
3–<6 years	24	60	US-EPA, 1996.
6–<11 years	24	46	
11–<16 years	25	43	
16–<21 years	33	60	
Bathing and Showering in minutes per day			
18–<65 years	17	-	US-EPA, 1996.
≥65 years	17	-	
Swimming in minutes per month			
0–<1 year	96	-	
1–<2 years	105	-	
2–<3 years	116	181	Children, Birth to < 21 years: US EPA re-analysis
3–<6 years	137	181	of source data from US EPA, 1996.
6–<11 years	151	181	
11–<16 years	139	181	
16–<21 years	145	181	Adults, ≥18 years: US EPA, 1996.
18–<65 years	45[a]	181	
≥65 years	40[a]	181	
Playing on Sand/Gravel in minutes per day			
0–<1 year	18	-	
1–<2 years	43	121	
2–<3 years	53	121	Children, Birth to < 21 years: US EPA re-analysis
3–<6 years	60	121	of source data from US EPA, 1996.
6–<11 years	67	121	
11–<16 years	67	121	
16–<21 years	83	-	Adults, ≥18 years: US EPA, 1996.
18–<65 years	0[a]	121	
≥65 years	0[a]	-	
Playing on Grass in minutes per day			
0–<1 year	52	-	
1–<2 years	68	121	
2–<3 years	62	121	Children, Birth to < 21 years: US EPA re-analysis
3–<6 years	79	121	of source data from US EPA, 1996.
6–<11 years	73	121	
11–<16 years	75	121	
16–<21 years	60	-	Adults, ≥18 years: US EPA, 1996.
18–<65 years	60[a]	121	
≥65 years	121[a]	-	
Playing on Dirt in minutes per day			
0–<1 year	33	-	
1–<2 years	56	121	
2–<3 years	47	121	Children, Birth to < 21 years: US EPA re-analysis
3–<6 years	63	121	of source data from US EPA, 1996.
6–<11 years	63	121	
11–<16 years	49	121	
16–<21 years	30	-	Adults, ≥18 years: US EPA, 1996.
18–<65 years	0[a]	121	
≥65 years	0[a]	-	

- Percentiles were not calculated for sample sizes less than 10 or in cases where the mean was calculated by summing the means from multiple locations or activities.

a) Median value, mean not available in US-EPA, 1996.

Note: All activities are reported in units of minutes/day, except swimming, which is reported in units of minutes/month.

There are 1,440 minutes in a day. Time indoors and outdoors may not add up to 1,440 minutes due to activities that could not be classified as either indoors or outdoors.

Source: Modified from US-EPA, 2009.

10.3 WHO

No recommendations on activity factors are provided by WHO.

10.4 Conclusion and Recommendations

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited. No recommendations have been provided by the WHO.

In the REACH TGD Chapter R8 (ECHA, 2008a), the recommendations are stated as *"taken from Gold et al., 1984 and ICRP, 1975"*; however, it is not clear whether the recommendations are taken from one of these references or both. The recommended values from ECETOC are based on different sources published in the 1990'ies.

The US-EPA recommended values are well validated as the general assessment factors (GAFs, described in Section 2.1) were used to judge the quality of the underlying data used to derive the recommendations. The US-EPA overall rating was medium for the mean and low for upper percentile.

Activity levels might be different among US individuals compared to Europeans. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommendations are considered as being the most valid values for activity factors. It should be noted that the recommended values in the 2009 version of the EFH (US-EPA, 2009) are based on two key studies published in 1991 and 1996 and the ECETOC recommendations are based on different sources published in the 1990'ies.

In conclusion, the US-EPA recommended values presented in Table 10.2 are considered as being the most valid values for activity factors for Europeans as today and are therefore recommended as default exposure factors for assessments of European inhabitants in the context of REACH. No default values for working activities are recommended by the US-EPA as the working environment is not the responsibility of US-EPA. For working activities, the recommended values presented in Table 10.1 are recommended as default exposure factors for assessments of European workers in the context of REACH.

11. Consumer Products

Consumer products may contain toxic or potentially toxic chemical constituents to which people may be exposed as a result of their use. For example, household cleaners can contain ammonia, alcohols, acids, and/or organic solvents which may pose health concerns. Potential routes of exposure to consumer products or chemicals released from consumer products during use include ingestion, inhalation, and dermal contact. These household consumer products include cleaners, solvents, and paints. Non-users, including children, can be passively exposed to chemicals in these products. Since people spend a large amount of time indoors, the use of household chemicals in the indoor environment can be a principal source of exposure. (US-EPA, 2009).

In order to estimate consumer product exposure, three exposure routes are to be considered: inhalation, dermal and oral routes, each exposure calculated separately (RIVM, 2006a):

Inhalation
It is assumed that all substances are released as a gas, vapour or airborne particulate into a standard room. This may be due to direct release or to evaporation from a liquid or a solid matrix

Dermal
Two options:

- The substance is contained in a preparation. This option is applicable when, for example, hands are put into a solution containing the substance under evaluation, or splashes occur (painting)
- Substance migrating from an article; applicable, for example, when residual dyes in clothing are in contact with skin and migrate from the clothing

Oral
Two options:

- Substance in a product unintentionally swallowed during normal use
- Substance migrating from an article; applicable for example when a substance migrates from a pen, cutlery or textile

11.1 Europe

As mentioned in section 1.1.2, RIVM has provided Fact Sheets with default values on several consumer products which are calculated using the ConsExpo software model. The default values in the fact sheets have been collected for Dutch consumers (non-professional users). They are not aimed at describing exposure for people who professionally work with consumer products, such as hairdressers and in hospitals, for example. These fact sheets, therefore, only describes consumer products which are available to the consumer for private use. The parameter values in the fact sheets are chosen such that a relatively high exposure and uptake are calculated, in the order of magnitude of a 99th percentile of the distribution. To achieve this goal, the 75th or the 25th percentile is calculated (or estimated) for each parameter. The 75th percentile is used for parameters which give a higher exposure for higher values, and the 25th percentile is used in the reverse case (RIVM, 2006a).In order to assess the exposed area, RIVM uses the default value for surface areas from the *General Fact Sheets* (RIVM, 2006a) (see Section 3.1) and the *Exposure Factors Handbook* (US-EPA, 2009) (see Section 3.2).

11.1.1 Cosmetics

The *Cosmetics Fact Sheet* (RIVM, 2006b) covers the use of cosmetics by consumers for 35 product categories including shampoo, make-up, lipstick, deodorant and toothpaste. Default models and values for all 35 product categories have been determined to assess exposure and intake of compounds in cosmetics (RIVM, 2006b).

Making exposure assessment on sprays can be very complicated and several parameters must be taken in to account – the room size where the spaying process takes place, the size of the droplets and the composition of the substance. Especially the size is important. During spraying the user can inhale droplets of the product. Sprays produce an aerosol cloud of very small to small droplets. The speed with which the droplets fall depends on the size of the droplet; smaller droplets stay in the air longer and smaller droplets are more prone to be inhaled. In the *Cosmetics Fact Sheet* (RIVM, 2006b), different terminologies are used in order to describe the exposure:

- *Cloud volume*: During the actual spraying of a cosmetic product towards a person, the person is exposed to an aerosol cloud with fine particles. In the ConsExpo 4.0 spray model, the volume of the cloud after 1 second is assumed to further increase linearly in time until spraying stops or the cloud volume equals the volume of the room. It is assumed that during the use of the spray (the actual spraying) the breathing zone of the exposed person is located inside this volume. After spraying, the sprayed material is assumed to be homogeneously

dispersed over the entire room. The default value for cloud volume is set at 1/16 m^3 or 0.0625 m^3. This cloud volume matches a cone measuring 1 m (length) and 0.5 m (diameter); in addition, it matches a sphere with a diameter of 0.5 m

- *Airborne fraction*: The airborne fraction is the fraction of non-volatile material that becomes airborne in the form of droplets. The airborne fraction depends on the way it is used, i.e. spraying on a surface (paint, wood preservative) or spraying in the air (spraying against flies), and on the droplet size distribution that has been specified. Several airborne fractions has been investigated and based on these measures, the default value for air space sprays and surface sprays with a median of the initial particle distribution < 50 μm is 1 and the default value for surface sprays with a median of the initial particle distribution ≥ 50 μm is 0.2
- *Initial particle distribution*: As mentioned earlier, the droplet size is an important parameter when estimating the exposure. Smaller drops fall at a lower speed and stay in the air for longer. The large droplets will quickly disappear from the air after being formed. As an indication: the falling time of droplets with a diameter of 100 μm from a height of 3 meters is calculated at 11 sec, and for droplets of 10 μm it is calculated at 17 min
- *Inhalation cut-off diameter*: The inhalation cut-off diameter is the measure for the diameter of the spray droplets that can be inhaled and reach the lower areas of the lungs (alveoli, bronchioles, bronchia). Particles that are above this diameter deposit in the higher parts of the respiratory tract and will be cleared via the gastro-intestinal tract, leading to oral exposure. The inhalation cut-off diameter is only an approximation of the complicated process of deposition of particles in the lung. In general its value should be around 10–15 micrometer. According to the RIVM, the default value is set at 15 μm
- *Density*: Many non-volatile substances in cosmetics are made of large organic compounds with densities usually between 1.0 and 1.5 g/cm^3. For a complex mixture of (especially organic) compounds, the density is set at 1.8 g/cm^3. The density of salts generally varies between 1.5 and 3.0 g/cm^3 (RIVM, 2006b)

In Table 11.1 a summary of general default values for cosmetic sprays is presented and in Table 11.2, default values for the density for solvents and for non-volatile compounds are presented.

Table 11.1: General Default Values for Cosmetic Sprays

Inhalation, spray model: spraying towards exposed person	Default value
Cloud volume	
Spray cans	0.0625 m^3
Pump sprays	0.0625 m^3
Airborne fraction	
Airspace sprays/surface sprays; median of the initial particle distribution < 50 µm	1 g/g
Surface sprays; median of the initial particle distribution ≥ 50 µm	0.2 g/g
Inhalation cut-off diameter	15 µm

Source: Modified from the *Cosmetics Fact Sheet*, RIVM (2006b)

Table 11.2: Default values for density

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

Source: Modified from the *Cosmetics Fact Sheet*, RIVM (2006b).

In the *Cosmetics Fact Sheet* (RIVM, 2006b) default values on the use of various cosmetic products are provided and selected default values are presented in Table 11.3. It should be noted that the majority of the products are assumed only to be used by women with a body weight of 61 kg. The "normal" use of cosmetics by children, such as the use of baby salves, baby powder, sunscreen lotions and toothpaste, for example, is presented in Table 11.3. Other cosmetic products used by children are presented in Section 11.2.6, in Table 11.15. It is assumed that the room temperature is 20 °C, that the room height is 2.5 m and that the uptake fraction (inhalation and oral) is 1.

Table 11.3: Default values of Cosmetic Products

	Default Value	Comments
Shampoo		
Frequency	260 x/year	Studies range between 2–7 times a week (default: 260 x/year = 5 x/week)
Dermal, instant application		
Exposed area	1440 cm^2	Area hands + ½ area head
Amount upon head $_{dilution}$	60 g	The estimation is that wet hair contains 40 g water + shampoo 20 g
Weight fraction $_{dilution}$	W_f / 3	Shampoo 20 g, total amount upon head 60 g: dilution factor 3
Exposure time	4 min	Mean: 1 min., max: 5–10 min,; assuming that shampoo after application is not rinsed out immediately
Conditioner		
Frequency	104 x/year	Studies range between 1–2 times a week (default:104/ year =2/week)
Dermal, instant application		
Exposed area	1440 cm^2	Area hands + ½ area head
Amount upon head dilution	54 g	The estimation is that wet hair contains 40 g water + conditioner 14 g
Weight fraction dilution	W_f / 3.9	Conditioner 14 g, total amount upon head 54 g: dilution factor 3.9
Exposure time	4 min	Mean: 1 min., max: 5–10 min,; assuming that conditioner after application is not rinsed out immediately

	Default Value	Comments
Hairspray, aerosol can[a)]		
Frequency	438 x/year	Studies range between 1–2 times per day; mean: 0.76 SD: 0.68 (default is calculated as follows: 75% mean: 0.76 a day and SD: 0.68 gives 1.2 x/ day i.e. 438 x/year)
Inhalation, spray model, spraying towards exposed person		
Spray duration	0.24 min	Studies range between 0.17–0.34 min per day; mean: 0.18 SD: 0.1 min. (default is calculated as follows: 75% mean: 0.18 and SD: 0.1 min. gives 0.24 min.)
Exposure duration	5 min	Estimate: time in bathroom
Room volume	10 m^3	Bathroom
Airborne fraction	1	see section 11.2
Weight fraction non-volatile	0.03 g/g	
Density non-volatile	1.5 g/cm^3	see section 11.2
Initial particle distribution Median (CV)	35 µm (0.3)	see section 11.2
Inhalation cut-off diameter	15 µm	see section 11.2
Inhalation rate	23.1 l/min	
Dermal		
Exposed area	565 cm^2	½ area head female
Amount upon head	0.6 g	
Exposure time	960 min	Estimate: 16 hours upon hair; at night, hair spray is brushed out
Hair styling, gel		
Frequency	358 x/year	Mean: 0.59 a day SD: 0.57 (default: 358 x/year = 0.98 x/day, i.e. calculated 75th percentile from 0.59 x/day and SD 0.57)
Dermal, instant application		
Exposed area no. 1	580 cm^2	½ area head
Amount upon head	0.3 g	10% of 2.9 g product amount which is 75th percentile from mean: 1.9 g, SD: 1.5
Exposure time	1440 min	Estimate
Exposed area no. 2	1010 cm^2	½ area hands + ½ area head
Amount product	2.9 g	75th percentile from mean: 1.9 g, SD: 1.5
Exposure time	0.63 min	75th percentile from mean: 0.48 min, SD: 0.22
Hair styling, mousse		
Frequency	274 x/year	Mean 0.41x/day SD: 0.50 (default: 274 x/ year = 0.75 x/day i.e. 75th percentile calculated from 0.41 x/day, SD: 0.50)
Dermal, instant application		
Exposed area no. 1	580 cm^2	½ area head
Amount upon head	0.3 g	10% of 2.7 g product amount which is 75th percentile from mean: 2.0, SD: 1.0
Exposure time	1440 min	Estimate
Exposed area no. 2	1010 cm^2	½ area hands + ½ area head
Amount product	2.7 g	75th percentile from mean; 2.0 g, SD: 1.0
Exposure time	0.67 min	75th percentile from mean: 0.4 min, SD: 0.2
Hair dye[b)]		
Frequency	10 x/year	Studies range between 8–12 times per year
Dermal, instant application		
Exposed area	580 cm^2	½ area head
Amount product	100 g	Studies range between 50 and 2 x 50 g
Exposure time	40 min	Estimation: 5 min. application and 5 min. rinsing out; initial period 20–40 min
Hair bleaching products[b)]		
Frequency	10x/year	
Dermal, instant application		
Exposed area	580 cm^2	½ area head
Amount product	200 g	Estimate based on different products
Exposure time	45 min	Estimate

	Default Value	Comments
Hair perm[b)]		
Frequency	4x/year	Estimate
Dermal, instant application		
Exposed area	580 cm^2	½ area head (Gloves are usually supplied with perm lotion. It is assumed that gloves are used during its application)
Amount product		
Perm lotion	80 g	
Fixing lotion	80 g	
Exposure time		
Perm lotion	40 min	
Fixing lotion	15 min	
Soap liquid, solid: washing hands		
Frequency	1825 x/year	3–6 x/day (default: 1825 x/yr = 5 x/day)
Dermal, instant application		
Exposed area	860 cm^2	Area hands
Amount upon skin dilution		
Soap liquid	3.0 g	Used amount 1.0 g, dilution factor 3
Soap solid	2.4 g	Used amount 0.8 g, dilution factor 3
Weight fraction dilution	W_f / 3	Estimate dilution factor 3 (wetting hands)
Exposure time	1 min	Estimate
Soap liquid, solid: showering		
Frequency	329 x/year	1–2 x/day
Dermal, instant application		
Exposed area	17 500 cm^2	Total body area
Amount upon skin dilution		
Soap liquid	26.1 g	Used amount 8.7 g; dilution factor 3
Soap solid	21.0 g	Used amount 7.0 g; dilution factor 3
Weight fraction dilution	W_f / 3	Estimate dilution factor 3 (use on wet skin)
Exposure time	4 min	
Bath products: bath foam, bath salts and bath oil		
Frequency	104 x/year	1–2 x/week; adults: 0.6 – 1.0/week
Dermal, instant application		
Exposed area	16 340 cm^2	area body – area head
Amount upon skin dilution	16 340 g	Estimate: 1 cm skin layer
Weight fraction dilution		
Bath foam	W_f / 7000	Dilution factor: 1700; 17g in 120 L
Bath salts	W_f / 4800	Dil. factor 4800; tablet of 25 g in 120 L
Bath oil	W_f / 13,000	Dilution factor13000; 9 g in 120 L3 i.e. 10 ml bath oil with density of 0.9 g/cm^3
Exposure time		
Bath foam/ bath salts		Estimate
Bath oil		Directions for use: 15–20 min
Cream: Hand cream, facial cream and body lotion[a)]		
Frequency	730 x/year	Estimate; based on different studies; 1–2 x per day
Dermal, instant application		
Exposed area		
Hand cream	860 cm^2	Area hands
Facial cream	565 cm^2	½ area head female
Body lotion	15 670 cm^2	Area body – area head female
Amount product		
Hand cream	1.7 g	
Facial cream	0.8 g	
Body lotion	8 g	Studies range between 7.5–8 g
Exposure time	720 min	12 hours, estimate as a result of frequency
Peeling gel (face)[a)]		
Frequency	104 x/year	1–2 x per week: directions for use
Dermal		
Exposed area	565 cm^2	½ area head female
Amount product	0.8 g	
Exposure time	5 min	Estimate
Face packs: peel-off masks, mud and gel face packs[a)]		
Frequency	104 x/year	1–2 x per week
Dermal, instant application		
Exposed area	565 cm^2	½ area head female
Amount product	20 g	
Exposure time	20 min	

	Default Value	Comments
Body packs: mud bath /clay bath[a)]		
Frequency	4 x/year	
Dermal, instant application		
Exposed area	15 670 cm^2	area body – area head
Amount product	416 g	
Exposure time	20 min	
Skin whitening cream[a)]		
Frequency	91 x/year	Estimate, an everyday use for three months is assumed
Dermal, instant application		
Exposed area	565 cm^2	½ area head female
Amount product	5 g	
Exposure time	1440 min	24 hours
Facial make-up/foundation[a)]		
Frequency	365 x/year	Estimate, once per day
Dermal, instant application		
Exposed area	565 cm2	½ area head female
Amount product	0.8 g	Estimate, face cream: 0.8 g
Exposure time	960 min	Estimate, 16 hours
Cleansing lotion/make-up remover[a)]		
Frequency	730 x/year	Studies range between 1–2 times per day
Dermal		
Exposed area	565 cm^2	½ area head female
Amount product	2.5 g	
Exposure time	5 min	Estimate
Eye shadow[a)]		
Frequency	730 x/year	1–3 x/day
Dermal, instant application		
Exposed area	24 cm^2	4 x 3 x 2 =24 cm^2 (eyelids and the skin under the eyebrows)
Amount product	0.01 g	
Exposure time	480 min	Estimate as a result of frequency
Mascara[a)]		
Frequency	365 x/year	Once per day
Dermal, instant application		
Exposed area	1.6 cm^2	Area of eyelashes
Amount product	0.025 g	
Exposure time	960 min	Estimate as a result of frequency
Eyeliner[a)]		
Frequency	365 x/year	Once per day
Dermal, instant application		
Exposed area	3.2 cm^2	4 x 0.2 x 4 = 3.2 cm^2 (eyeliner is applied as a thin line on the eyelid just above or below the eyelashes)
Amount product	0.005 g	
Exposure time	960 min	Estimate as a result of frequency
Eye make-up remover[a)]		
Frequency	365 x/year	1–2 times per day
Dermal, instant application		
Exposed area	50 cm^2	5 x 5 x 2 = 50 cm^2 (where eye make-up is applied)
Amount product	0.5 g	
Exposure time	5 min	Estimate
Lipstick/ lip salve[a)]		
Frequency	1460 x/year	2–6 x/day; default: 4 x/day
Oral, direct intake		
Amount product	0.01 g	
Amount ingested	0.01 g	It is assumed that the entire product is taken in orally

	Default Value	Comments
Nail polish[a, c)]		
Frequency	156 x/year	2–3 times a week
Inhalation, evaporation from a constant surface		
Exposure duration	5 min	Estimate
Product amount	0.25 g	
Application duration	5 min	Estimate
Room volume	1 m^3	The application of the nail polish takes place close to the face. Therefore it is assumed that when the nail polish is applied evaporation takes place in an initial area of 1 m^3.
Ventilation rate	1 hr^{-1}	Bedroom
Release area	19 cm^2	It is assumed that a fingernail has an area of 1 x 1.5 cm, and then the total fingernail area is 15 cm^2. For the contact of nail polish with the skin, a nail perimeter (i.e. the two sides of the nail and the nail bed) of 4 cm is assumed with a breadth of 1 mm. This gives an exposed area of 4 cm^2 for the skin around the fingernails, i.e. 15 + 4 cm^2 = 19 cm^2.
Mol. weight matrix	124 g/mol	The evaporation includes the parameter "molecular weight matrix". This parameter is used to calculate the relative vapour pressure of the component in question. Nail polish contains 75% organic solvents; ethyl acetate (Mw = 88), butyl acetate (Mw = 116), ethyl alcohol (Mw = 46) and toluene (Mw = 92) in the ratio 4 : 3: 1: 7 40). The molecular weight matrix is calculated as: [4/15 * 88 + 3/15 * 116 + 1/15 * 46 + 7/15 * 92] : 0.75 = 124 g/mol.
Inhalation rate	23.1 l/min	
Dermal, instant application		
Exposed area	4 cm^2	The skin around the fingernails
Amount upon skin	0.05 g	0.25 x 4 / 19 = 0.05 g
Exposure time	3360 min	Estimate as a result of frequency
Nail polish remover [a, c)]		
Frequency	156 x/year	2–3 times a week
Inhalation, evaporation from a constant surface		
Exposure duration	5 min	Estimate
Product amount	0.5 g	Estimate
Application duration	5 min	Estimate
Room volume	1 m^3	See nail polish
Ventilation rate	1 hr^{-1}	Bedroom
Release area	25 cm^2	See nail polish; a larger area than nail polish is used in order to remove the nail polish
Mol. weight matrix	75 g/mol	See nail polish; (Mw = 88), butyl acetate (Mw = 116) are assumed as solvents in the ratio 13:4:1 40). The molecule weight matrix is calculated as [13/18 * 58 + 4/18 * 88 + 1/18 * 116]: 0.91 = 75 g/mol (see nail polish scenario).
Inhalation rate	23.1 l/min	
Dermal, instant application		
Exposed area	11 cm^2	1.2 x 0.2 x2 = 11 cm^2 (the skin around the fingernails)
Amount upon skin	0.2 g	Estimate (0.5 x 11/26 = 0.2 g)
Exposure time	5 min	Estimate
Deodorant stick/ roller		
Frequency	365 x/year	Roller 1x per day
Dermal, instant application		
Exposed area	100 cm^2	Estimate
Amount product	0.5 g	
Exposure time	1440 min	Estimate as a result of frequency

	Default Value	Comments
Deodorant spray		
Frequency	730 x/year	Spray 1–3 x per day
Inhalation, spray model, spraying towards exposed person		
Exposure duration	5 min	Estimate: time in bathroom after spraying
Spray duration	0.17 min	Estimate; default: 0.17 min = 10 sec
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Cloud volume	0.0625 m^3	See Table 11.2.1.1.
Mass generation rate	0.40 g/sec	Mean mass generation rate during the entire duration of spraying (full and nearly empty sprays)
Airborne fraction	1 g/g	see section 11.2
Weight fraction non-volatile	0.03 g/g	
Density non-volatile	1.8 g/cm^3	see section 11.2
Initial particle distribution Median (CV)	10 µm (0.3)	see section 11.2
Inhalation cut-off diameter	15 µm	see section 11.2
Inhalation rate	23.1 l/min	
Dermal, instant application		
Exposed area	100 cm^2	Estimate
Amount upon skin	2.6 g	85% of 3.0 g – it is assumed that only 85% ends up on the skin
Exposure time	720 min	Estimate as a result of frequency
Toothpaste, adults		
Frequency	730 x/year	1–2 per day
Oral, direct intake		
Amount ingested	0.08 g	
Toothpaste, children 2.5 years[d)]		
Frequency	730 x/year	1–2 times per day
Oral, direct intake		
Amount ingested	0.53 g	
Mouthwash		
Frequency	1460 x/year	Studies range between 1–5 times per day; default 1460 x/year = 4x/day
Oral, direct intake		
Amount ingested	1 g	
Foot cream antiperspirant		
Frequency	730 x/year	1–2 times per day; directions for use
Dermal, instant application		
Exposed area	1170 cm^2	Area foot
Amount product	1.2 g	An amount of 1 mg/cm^2 is given for the use of cream in general. The surface area of feet is 1170 cm^2. The amount of cream used is calculated at 1.2 g.
Exposure time	720 min	Estimate as a result of frequency
Foot cream anti-fungal[c)]		
Frequency	90 x/year	Directions for use: 2 times per day in approx. 45 days = 90 times per year.
Dermal, instant application		
Exposed area	100 cm^2	
Amount product	0.1 g	An amount of 1 mg/cm^2 is given for the use of cream in general. The surface area of feet is 1170 cm^2. It is assumed that the cream is applied to 100 cm^2 of the skin of the feet. The amount of cream used is calculated at 0.1 g.
Exposure time	720 min	Estimate as a result of frequency

	Default Value	Comments
Eau de toilette spray		
Frequency	1095 x/year	Studies range between 1–5 times per day; default: 3 x/day
Inhalation		
Exposure duration	5 min	Estimate: time in bathroom after spraying
Spray duration	0.08 min	Estimate; 5 sec, based on values for trigger sprays
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Cloud volume	0.0625 m^3	See Table 11.2.1.1.
Mass generation rate	0.14 g/sec	The mean mass generation rate is calculated from the sprayed amount (0.72 g) and the total duration of spraying (5 sec), which is 0.14 g/sec.
Airborne fraction	0.2 g/g	see section 11.2
Weight fraction non-volatile	0.05 g/g	
Density non-volatile	1.5 g/cm^3	see section 11.2
Initial particle distribution Median (CV)	50 µm (0.6)	see section 11.2
Inhalation cut-off diameter	15 µm	see section 11.2
Inhalation rate	23.1 l/min	
Dermal, instant application		
Exposed area	200 cm^2	Estimate; the default value for the exposed body surface is set at 8 x 25 cm^2 = 200 cm^2.
Amount upon skin	0.61 g	It is assumed that 85% of the eau de toilette ends up on the skin, therefore 0.61 g (0.85 x 0.72 g) ends up on the skin.
Exposure time	320 min	Estimate as a result of frequency
Perfume[e)]		
Frequency	237 x/year	Mean: 0.26 times per day
Dermal, instant application		
Exposed area	100 cm^2	As perfume contains more fragrance than eau de toilette, the body surface onto which the perfume is sprayed will be smaller: 4 x 25 cm^2 = 100 cm^2.
Amount upon skin	0.20 g	0.23 g per application – it is assumed that 85% of the perfume ends up on the skin: 0.20 g.
Aftershave[f)]		
Frequency	365 x/year	1–2 x/day
Dermal, instant application		
Exposed area	305 cm^2	¼ area head male
Amount product	1.2 g	
Exposure time	1440 min	Estimate as a result of frequency
Shaving cream[f)]		
Frequency	365 x/year	1 x/day
Dermal		
Exposed area	305 cm^2	¼ area head male
Amount product	2 g	
Exposure time	5 min	Estimate
Sunscreen lotion		
Frequency	75 x/year	2–3 times per day for a period of 2 weeks/ year for the use of sunscreen cream, and 1 week in the winter for just the face. Based on this data the default value assumes use 3 times per day over a period of 25 days. (default:75x/ year = 3 x/day, 25 days/year)
Dermal, instant application		
Exposed area	17 500 cm^2	
Amount product	10 g	Cream 8 g, lotion 10 g
Exposure time	150 min	Estimate

	Default Value	Comments
Baby products: baby cream/salve, baby oil and baby powder[e, g)]		
Frequency	730 x/year	Estimate; default: 730 x/ year = 2 x/day
Dermal, instant application		
Exposed area	190 cm^2	The default of the total body surface area of a child of four and a half months is 0.346 m^2, and the surface area of the torso is 32.8% of this body surface. The estimate for the surface of a baby's bottom is 1/6 of the exposed area of the torso, that is 1/6 x 0.328 x 3460 cm^2 = 190 cm^2
Amount product		
Baby cream/salve	0.27 g	
Baby oil	1.3 g	
Baby powder	0.8 g	
Exposure time	720 min	Estimate as a result of frequency
Depilatory cream[a)]		
Frequency	17 x/year	Wax indicates that hairs will not grow back for between 3 and 6 week depending on the hair growth; 17x/year = 1 x/3 weeks
Dermal, instant application		
Exposed area	5530 cm^2	Area female legs
Amount product	5.5 g	1 mg/ cm^2; hair removal from legs
Exposure time	15 min	Studies range between 5–15 min
Essential oil: massage		
Frequency	24 x/year	Estimate, 2 x/month
Dermal, instant application		
Exposed area	16 340 cm^2	area body – area head
Amount product	8 g	During a massage oil is rubbed into the body several times, and it is assumed that the use of massage oil is in the same order of magnitude as that of body lotion; default value 8 g
Exposure time	30 min	Estimate
Essential oil: bath		
Frequency	52 x/year	Studies range between 0,6–2 times per week
Dermal, instant application		
Exposed area	16 340 cm^2	area body – area head
Amount upon skin dilution	16 340 g	Estimate: 1 cm skin layer; As default value it is assumed that 10 ml of bath product (10 ml oil with density of 0.9 g/cm^3 i.e. 9 g) with 30% essential oils is added to 120 litres of bath water
Weight fraction dilution	W_f / 13000	Dilution factor 13000: 9 g in 120 litre (10 ml oil with density of 0.9 g/cm^3)
Exposure time	20 min	Directions for use: 15–20 min
Essential oil: air freshener		
Frequency	168 x/year	
Inhalation, evaporation, constant rate		
Exposure duration	240 min	4 hrs
Product amount	1.08 g	1 drop oil is about 50 µl which equals 45 mg (density 0.9 g/cm^3); 24 drops oil equal 1.08 g
Room volume	58 m^3	Living room
Ventilation rate	0.5 h^{-1}	Living room
Emission duration	180 min	Estimate
Inhalation rate	23.1 l/min	
Face paint, adult		
Frequency	6 x/year	Estimate
Dermal, instant application		
Exposed area	580 cm^2	½ area head
Amount product	1.7 g	With regard to the amount of face paint used, it is assumed that this is 3 times as large as the amount used for a general cream, that is 3 mg/cm^2
Exposure time	480 min	Estimate, 8 hours

	Default Value	Comments
Face paint, child[h)]		
Frequency	12 x/year	Estimate
Dermal, instant application		
Exposed area	475 cm^2	½ area head
Amount product	1.4 g	With regard to the amount of face paint used, it is assumed that this is 3 times as large as the amount used for a general cream, that is 3 mg/cm^2
Exposure time	480 min	Estimate, 8 hours

a) Only females – having an assumed body weight of 61 kg.

b) Gloves are usually supplied with the product. It is assumed that gloves are used during its application.

c) For the dermal exposure the amount that is applied to the nail is not important, only the amount that is applied to the skin.

d) Assuming a body weight of 12.5 kg.

e) Data taken from the *Exposure Factors Handbook*, US-EPA (1997).

f) Only males – having an assumed body weight of 74 kg.

g) Assuming a body weight of 6.21 kg for a 4.5 months old child.

h) Assuming a body weight of 16.3 kg for a 4.5 years old child.

Source: Modified from the *Cosmetics Fact Sheet*, RIVM (2006b).

Note: All references are cited in the *Cosmetics Fact Sheet*, RIVM (2006b).

11.1.2 Cleaning products

In the *Cleaning Product Fact Sheet*, RIVM (2006c) cleaning products are classified into 36 product categories, which are drawn up according to the type of product. As in the *Cosmetics Fact Sheet*, RIVM (2006b) various default exposure models are chosen and filled in with default parameter values. These models are thoroughly described in the Fact Sheets, but will only shortly be mentioned here, when necessary. The *Technical Notes for Guidance on Human Exposure to Biocidal Products* (TNsG) has provided most of the data used in this fact sheet (TNsG, 2007).

Most cleaning products are ready for use. However, some of the cleaning products require preparation before they can be used; so-called mixing and loading has to be applied first. During the mixing and loading process additional exposure may occur.

The parameters during the spraying process is mentioned in the previous section, however, there are some differences when spraying with cosmetics and cleaning products. Cosmetics sprays are used directly towards the consumer whereas cleaning products are used to clean different surfaces away from the consumer. Here, only the parameters that differ from the spraying process for cosmetics are mentioned.

- *Spray duration and exposure duration:* The duration of spraying and rinsing/cleaning is directly related to the size of the cleaned area. The default values for spraying and for cleaning are set at 14.3 sec/m^2 and 110 sec/ m^2, respectively, based on a pilot study (RIVM, 2006c)

- *Mass generation rate:* The default value for mass generation rate is set at 0.78 g/sec and it is used for the following trigger sprays: all-purpose spray, bathroom spray, glass spray and oven spray. This default value is based on different studies (RIVM, 2006c)
- *Initial particle distribution:* This parameter is described under "cosmetics", however, default values for initial particle distribution for cleaning sprays are given. For aerosol spray cans, the default is a lognormal distribution with median 25 µm, coefficient of variation 0.4. For trigger sprays, the default is a lognormal distribution with median 100 µm, coefficient of variation 0.6 (RIVM, 2006c)
- *Airborne fraction:* The default values for airborne fraction are identical for cosmetic sprays and cleaning sprays
- *Density:* See under "cosmetics"
- *Inhalation cut-off diameter:* See under "cosmetics"

In the *Cleaning Product Fact Sheet*, RIVM (2006c), dermal exposure of the user during application is calculated based on the "constant rate" model from ConsExpo. The *Technical Notes for Guidance on Human Exposure to Biocidal Products* (TNsG, 2007) has provided the data for this model. For the "constant rate" model the parameter "contact rate" is required. The contact rate is the rate at which the product is applied to the skin, in weight per time unit. The "constant rate" model is used for all spray applications. The following parameters are used in the "constant rate" model:

- *Contact rate aerosol spray cans:* The dermal exposure on hands and forearms ranges from 1.7 to 156 mg/min with a 75th percentile of 64.7 mg/min. The dermal contact rate for legs, feet and face ranges from 17 to 45.2 mg/min with a 75th percentile of 35.7 mg/min. Using these data, the default value for contact rate aerosol spray cans is set at 100 mg/minute (RIVM, 2006c)
- *Contact rate trigger sprays:* The dermal exposure on hands and forearms ranges from 3 to 68.2 mg/min with a 75th percentile of 36.1 mg/min. The dermal contact rate for legs, feet and face ranges from 1.9 to 12.4 mg/min with a 75th percentile of 9.7 mg/min. Using these data, the default value for contact rate for trigger sprays is set at 46 mg/minute

In Table 11.4, an overview is given for the default values of aerosol spray cans and trigger sprays and in Table 11.5, default parameters that are used repeatedly in the *Product Fact Sheet*, RIVM (2006c) are provided. Table 11.6 presents default values on cleaning products for non-professional use as described in the *Cleaning Product Fact Sheet*, RIVM (2006c).

Table 11.4: Overview of Default Values of Aerosol Cans and Trigger Sprays

	Default Value
Aerosol Spray Can	
Inhalation, spray model	
Mass generation rate	1.5 g/sec
Airborne fraction	1 g/g
Density non-volatile	1.8 g/cm^3
Initial particle distribution; median (CV)	25 µm (0.4)
Inhalation cut-off diameter	15 µm
Dermal, constant rate	
Contact rate	100 mg/min
Trigger Sprays	
Inhalation, spray model	
Mass generation rate	0.78 g/sec
Airborne fraction	0.2 g/g
Density non-volatile	1.8 g/cm^3
Initial particle distribution; median (CV)	100 µm (0.6)
Inhalation cut-off diameter	15 µm
Dermal, constant rate	
Contact rate	46 mg/min

Source: Modified from the *Cleaning Product Fact Sheet*, RIVM (2006c).

Table 11.5: Default Values Used Repeatedly in the Fact Sheet- Supplement to Table 11.6

	Default value
Ventilation rates (inhalation model – spraying and evaporation)	
Bathroom/toilet	2.0 h^{-1}
Kitchen	2.5 h^{-1}
Living room	0.5 h^{-1}
Garage	1.5 h^{-1}
Non-specified room	0.6 h^{-1}
Room temperature (inhalation model)	20 °C
Room volumes (inhalation model – spraying and evaporation)	
Bathroom	10 m^3
Toilet	2.5 m^3
Kitchen	15 m^3
Living room	58 m^3
Garage	34 m^3
Non-specified room	20 m^3
Standard room height (inhalation model – spraying and evaporation)	2.5 m
Uptake fraction (inhalation, dermal and oral uptake)	1 (potential dose)
Inhalation rate (inhalation)	24.1 l/min (light exercise)

These parameters are used in Table 11.2.2.3. unless else is stated.

Source: The *Cleaning Product Fact Sheet*, RIVM (2006c).

Table 11.6: Default Values on Cleaning Products

	Default Value	Comments
Laundry powder: filling the washing machine		
Frequency	365 year $^{-1}$	Based on different studies it is estimated that a consumer typically fills the washing machine 7 times a week
Inhalation, instantaneous release		
Exposure duration	0.25 min	Estimate is based on one study
Product amount	2.7 * 10^{-7} g	A cup containing 200 gram of washing powder can generate 0.27 µg dust.
Room volume	1 m^3	"Room volume" is interpreted here as "personal volume": a small area of 1 m^3 around the user.
Laundry powder: hand washing		
Frequency	104 year $^{-1}$	Estimate: 2 week^{-1}
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Weight fraction dilution	0.01 * W_f	The concentration of laundry detergent for the hand-wash is 0.1% to 1%. Worst-case, the weight fraction of the diluted detergent is 1% of the used detergent powder.
Product amount dilution	19 g	It is assumed that not the total amount of diluted product is in contact with the skin but only a layer around the exposed skin. It has been estimated that the thickness of a product layer on the skin at 0.01 cm. The exposed area is 1900 cm^2; thus, the amount of diluted product is 19 cm^3 or 19 g
Concentration dilution	0.01*W_f g/cm^3	Diffusion trough skin. Density water 1 g/cm^3
Exposure time	10 min	
Laundry powder: residues on clothing		
Frequency	365 year^{-1}	It is assumed that one wears clothes, e.g. underwear, nightclothes, blouses, trousers and socks, every day during 24 hours.
Dermal		
Leachable fraction	0.003 * W_f	The leachable fraction is the relative amount of chemical which can leach from a product (g/g) i.e. the fraction of deposits of the detergent which can leach from textile. The leachable weight fraction depends on the composition of the detergent, the compound in question and the type of textile. Because there are no data for the amount of detergent residues leaching from the textile, it is assumed that 50% is leachable. The calculation for the leachable weight fraction is as follows: 6 x 10^{-3} g/g x 0.5 x W_f = 3 x 10^{-3} x W_f
Product amount	1000 g	The total weight of fabric i.e. average weight product during the day that is worn on the body is estimated at 1000 gram.
Skin contact factor	0.8	For the calculation of the skin-contact factor (i.e. the part of the product that is actually in contact with bare skin) it is assumed that 1/2 of the clothes are in direct contact with the skin (e.g. underwear, Fskin =1) and 1/2 contacts on and off the skin (e.g. blouses, Fskin = 0.6). The skin-contact factor then becomes 0.5 x 1 + 0.5 x 0.6 = 0.8.
Laundry liquid: filling the washing machine		
Frequency	365 year $^{-1}$	The frequency ranges from 2.8–10 times a week. The default value is 7 times a week.
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	Studies on exposure duration for filling the dishwasher range from 6 to 45 seconds with a mean of 23 s. The calculated 75th percentile is 34.6 sec or 0.58 min. The maximal duration of 45 s or 0.75 min is set as default value.
Product amount	500 g	This parameter is for limiting the evaporated amount of compound from the product. It is not the used product amount but half of the bottle content. For a one-litre bottle the averaged amount liquid in the bottle is estimated at 500 g (density 1 g/cm^3), which is set as default value.
Room volume	1 m^3	See "Laundry powder: filling the washing machine"
Release area	0.002 m^2	It is assumed that evaporation takes place from a bottle with a not-too-small circular opening with a 5 cm diameter which gives a release area of 20 cm^2.
Application duration	0.3 min	Estimation
Mol. weight matrix	90 g/mol	The fraction of water is estimated at 20%; the molecular weight matrix becomes 18 g/mol / 0.2 = 90 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: 1/4 area hands
Product amount	0.010 g	Estimate. For comparison, one small drop liquid is about 0.02 ml or 0.02 g
Exposure time	0.75 min	I.e. exposure duration

	Default Value	Comments
Spray spot remover: spraying[a)]		
Frequency	128 year $^{-1}$	Studies range from 0.06 to 0.82 a day, with a weighted mean of 0.35 a day.
Inhalation, spray model		
Spray duration	0.05 min	The default value for the mass generation rate of a spray is 1.5 g/sec. For spray spot remover, the used amount was 3.9 gram per task. Therefore, it is calculated, that the period of active spraying is 3.9 g / 1.5 g/s = 2.6 seconds. The default value for spray duration is set at 3 seconds or 0.05 min.
Exposure duration	10 min	Estimate
Mass generation rate	1.5 g/sec	See above
Airborne fraction	0.2 g/g	See above
Weight fraction non-volatile	0.1 g/g	Pre-wash soil and stain removers contain 5–15% surfactants. Based on the general composition, it is assumed that the non-volatile part in spray spot removers is about 10%; the default value weight fraction non-volatile is set at 0.1 g/g.
Density non-volatile	1.8 g/cm^3	See above
Initial particle distribution Median (CV)	100 µm (0.6)	See above
Inhalation cut-off diameter	15 µm	See above
Oral uptake fraction	1	Potential dose
Dermal, constant rate		
Contact rate	46 mg/min	See above
Release duration	0.05 min	I.e. spray duration
Spray spot remover: washing		
Frequency	128 year^{-1}	Studies range from 0.06 to 0.82 a day, with a weighted mean of 0.35 a day.
Dermal, instant application		
Exposed area	430 cm^2	½ area hands
Weight fraction dilution	0.1 * W_f	Dilution 10x
Product amount dilution	2.0 g	For spray spot removers, the amount per task is 3.9 gram. For estimating dermal exposure, it is assumed that 5% of the amount contacts the skin, i.e. 0.2 g. Taken the dilution into account (10 times), the default value for the diluted product amount is set at 2.0 g.
Concentration dilution	0.1 * W_f g/cm^3	Diffusion trough skin. Density water 1 g/cm^3
Exposure time	10 min	Estimate
Liquid spot remover/pastes		
Frequency	128 year^{-1}	Studies range from 0.06 to 0.82 a day, with a weighted mean of 0.35 a day
Dermal, instant application		
Exposed area	430 cm^2	½ area hands
Weight fraction dilution	0.1 * W_f	Dilution 10x
Product amount dilution	0.65 g/2.5 g	For liquid spot removers, the amount per task is 1.3 gram. Assuming that 5% contacts the skin and taking the dilution of 10 times into account, the default value is set at 0.65 g diluted product/For pastes, the default value is 5% of 5 gram i.e. 0.25 g. Assuming that 5% contacts the skin and taking the dilution of 10 times into account, the default value is set at 2.5 g diluted product
Concentration dilution	0.1 * W_f g/cm^3	Diffusion trough skin. Density water 1 g/cm^3
Exposure time	10 min	Estimate
Dishwashing liquid: mixing and loading		
Frequency	426 year^{-1}	Studies range between 3–21 times a week and a mean value of 0.63 per day with a 75-percentile of 1.17 day per day (n=45), which results in a frequency of 426 per year.
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	See “Laundry liquid: filling the washing machine”
Product amount	500 g	See “Laundry liquid: filling the washing machine”
Room volume	1 m^3	See “Laundry powder: filling the washing machine”
Release area	0.002 m^2	See “Laundry powder: filling the washing machine”
Application duration	0.3 min	Estimation
Mol. weight matrix	36 g/mol	Assuming the product contains 50% water, the molecular weight matrix is 18 g/mol / 0.5 = 36 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.010 g	Estimate
Exposure time	0.75 min	I.e. exposure duration

	Default Value	Comments
Dishwashing liquid regular: hand-wash[b)]		
Frequency	426 $year^{-1}$	See "Dishwashing liquid: mixing and loading"
Inhalation, evaporation from constant surface		
Exposure duration	60 min	Estimate
Product amount dilution	15000 g	This parameter is to limit the evaporated amount of compound from the product. The amount is calculated by multiplying the release area of 1500 cm^2 with a water height of about 10 cm resulting in an amount of 15,000 cm^3 water i.e. 15,000 gram.
Weight fraction dilution	W_f / 714	Studies range between 3–10 g with a 75th percentile of 7 gram (per 5 litres). This gives a concentration of 1.4 g/l. The fraction in the washing-up bowl is 7 g / 5000 g = 1.4 x 10^{-3} of the dishwashing product. This means a dilution of about 714 times; the weight fraction of the solution is the weight fraction of the product divided by the dilution factor (W^f / 714).
Release area	0.15 m^2	When doing the dishes, the release area equals the surface of the sink. In a study the 75th percentile of the surface of the sinks was calculated as 1453 cm^2. The default value is set at 0.15 m^2
Application duration	16 min	In one study, the duration of contact per event was 11 min with a 75th percentile of 16 min, which is set as default value for application duration (inhalation exposure) and for exposure time (dermal exposure).
Temperature	45° C	Initially, the temperature of the dishwater is high, approximately 60 °C and while doing the dishes, the temperature will decrease. The most frequently used dishwashing temperatures are in the range of 40–45 °C. Therefore, the default value for the "average" temperature is estimated at 45 °C.
Mol. weight matrix	18 g/ mol	Matrix is water; see "Dishwashing liquid: mixing and loading"
Dermal, instant application		
Exposed area	860 cm^2	Area hands
Weight fraction dilution	W_f / 714	See under "Inhalation"
Product amount dilution	8.6 g	Skin layer: 0.01 cm
Concentration dilution	W_f / 714 g/cm^3	Diffusion trough skin. Density water 1 g/cm^3
Exposure time	16 min	I.e. application duration
Dishwashing liquid: residues on dinnerware		
Frequency	365 $year^{-1}$	Estimate – once a day.
Oral, direct intake		
Amount ingested	4.2 * 10^{-4} g	According to one study, the value for amount of water left on dishes is 5.5 x 10–5 ml/cm^2 and the value for the area of dishes in daily contact with food is 5400 cm^2. The concentration of the dishwashing water is 1.4 g/l. Therefore, the ingested product amount is 5.5 x 10–5 ml/ cm^2 x 5400 cm^2 x 1.4 mg/ml = 0.4158 mg.
Liquid, rinse aid: filling the dishwashing machine		
Frequency	35 $year^{-1}$	It is estimated that the use is 2 times per 3 weeks
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	See "Laundry liquid: filling the washing machine"
Product amount	500 g	See "Laundry liquid: filling the washing machine"
Room volume	1 m^3	See "Laundry powder: filling the washing machine"
Release area	0.002 m^2	See "Laundry powder: filling the washing machine"
Application duration	0.3 min	Estimation
Mol. weight matrix	60 g/ mol	The fraction of water in polishing liquid is estimated at 0.3; so, the molecular weight fraction is 18 g/mol / 0.3 = 60 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.010 g	Estimate
Exposure time	0.75 min	I.e. exposure duration

	Default Value	Comments
All-purpose cleaner liquid: mixing and loading		
Frequency	104 $year^{-1}$	Based on two studies, the mean use is two times per week
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	See "Laundry liquid: filling the washing machine"
Product amount	500 g	See "Laundry liquid: filling the washing machine"
Room volume	1 m^3	See "Laundry powder: filling the washing machine"
Release area	0.002 m^2	See "Laundry powder: filling the washing machine"
Application duration	0.3 min	Estimation
Mol. weight matrix	22 g/mol	The fraction of water in the product is estimated at 0.8. For the molecular weight matrix, the default value is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.010 g	Estimate
Exposure time	0.75 min	I.e. exposure duration
All-purpose cleaners: cleaning furniture[c)]		
Frequency	104 $year^{-1}$	See "All-purpose cleaner liquid: mixing and loading"
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Default
Product amount dilution	400 g	In a limited experiment 40 ml suds was spread on a surface of 1 $^m2$. The area was quite soaked; therefore, it is assumed that the amount left on the surface is not exceeding 40 ml per m^2. The amount of suds for an area of 10 m^2 is set at 400 ml or 400 g.
Weight fraction dilution	W_f / 80	Studies range between 25–110 g per 5 litres of wash volume. Based on the 75th percentile, a total of 63 g per 5 litres is used as default, which gives a dilution of 80 times. The weight fraction of the suds is the weight fraction of the product divided by the dilution factor (W_f / 80).
Release area	10 m^2	See "Product amount dilution"
Application duration	20 min	Based on two studies
Mol. weight matrix	18 g/ mol	Matrix is water; see "Dishwashing liquid: mixing and loading"
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Weight fraction dilution	W_f / 80	See "Inhalation"
Product amount dilution	19 g	Skin layer 0.01 cm
Concentration dilution	W_f /80 g/cm^3	Diffusion trough skin. Density water 1 g/cm^3
Exposure time	20 min	I.e. application duration
All-purpose spray cleaner: spraying the kitchen working top[b)]		
Frequency	365 $year^{-1}$	Estimate: 1 day^{-1}
Inhalation, spray model		
Spray duration	0.41 min	One study has calculated the 75th percentile for the spraying as 14.3 sec. per m^2. For an area of 1.71 m^2, the spraying time is 0.41 min
Exposure duration	60 min	Estimate
Mass generation rate	0.78 g/sec	See Table 11.2.2.1.
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.05 g/g	Based on the general composition, it is assumed that the non-volatile part in all-purpose spray cleaners is about 5%; the default value weight fraction non-volatile is set at 0.05 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	100 µm (0.6)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	46 mg/min	See Table 11.2.2.1.
Release duration	0.41 min	I.e. spray duration

	Default Value	Comments
All-purpose spray cleaner: leaving on and cleaning the kitchen working top[b)]		
Frequency	365 $year^{-1}$	Estimate: 1 day^{-1}
Inhalation, evaporation from constant surface		
Exposure duration	60 min	Estimate
Product amount	16.2 g	The 75th percentile of the used amount is 4.016 g per 0.36 m^2; thus, the amount for an area of 1.71 m^2 is 19.1 g. The amount on the surface that evaporates into the room is estimated at 85% of 19.1 g i.e. 16.2 gram
Release area	1.71 m^2	The average area of a kitchen working top
Application duration	10 min	The application duration is the time that the compound evaporates from the kitchen working top and includes the spray duration, the "leaving on" time and the cleaning time. The spray duration is 0.41 min; the calculated 75th percentiles for the cleaning time is 110 sec. per m^2. For an area of 1.71 m^2, the cleaning time is 3.2 min; the value for "leaving on time" is 5 minutes. Therefore, the application duration is estimated at 10 min.
Mol. weight matrix	22 g/mol	Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.16 g	It is assumed that 1% of the product amount gives dermal exposure and 1% of 16.2 g product is 0.16 g
Exposure time	3.2 min	Diffusion through skin during cleaning
Wet tissues: cleaning[d)]		
Frequency	365 $year^{-1}$	Estimate: 1 day^{-1}
Inhalation, evaporation from increasing area		
Exposure duration	60 min	Estimate
Product amount	3.42 g	In one study, the average wet fraction of the tissues equaled 3.37 gram with a 75th percentile of 3.42 gram
Release area	2 m^2	Estimate
Application duration	2 min	Estimate
Mol. weight matrix	22 g/mol	Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.047 g	When firmly touching the wet tissue, 0.044 g remains on the surface of the inner hand area. This gives a 75th percentile of 0.047 g, which is about 1.4% of the total average liquid fraction of the tissues
Exposure time	2 min	I.e. application duration
Liquid abrasives: cleaning[e)]		
Frequency	156 $year^{-1}$	
Inhalation, evaporation from increasing area		
Exposure duration	10 min	Estimate
Product amount	37 g	The average in one study was 24 g and the 75th percentile was 36.9 g. Another study ranges between 20–40 g
Release area	4 m^3	Estimate
Application duration	7.6 min	For the large cleaning of the toilet (the interior and exterior of the toilet pan plus floor, basin, tiles and various attributes), one study gives an average duration of 366 sec which results in a 75th percentile of 457 sec or 7.6 min
Mol. weight matrix	45 g/mol	Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.37 g	It is assumed that 1% of the product amount gives dermal exposure and 1% of 37 g product is 0.37 g
Exposure time	7.6 min	I.e. application duration

	Default Value	Comments
Abrasive powders: scattering[b)]		
Frequency	104 year^{-1}	See "All-purpose cleaner liquid: mixing and loading"
Inhalation, spray model (inhalation/ oral exposure can occur to particles which whirl around in the air when using powders)		
"Spray" duration	1 min	For the scattering of powder on the kitchen working top and gas stove, the "spray" duration is estimated at 1 min.
Exposure duration	60 min	Estimate
Mass generation rate	0.62 g/sec	The default value for amount is set at 37 gram. The mass generation rate is calculated as follows: 37 gram / 60 sec = 0.62 g/s
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	1 g/g	Product
Density non-volatile	3 g/cm^3	> 95% salts, see Table 11.2.2.1.
Initial particle distribution Median (CV)	75 (0.6)	Based on a study. See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	5.0 mg/min	In one study, the dermal exposure on hands and forearms ranges from 0.4 to 4.18 mg/min with a 75th percentile of 2.83 mg/min. The dermal exposure for legs, feet and face ranges from 0.22 to 6.56 mg/min with a 75th percentile of 2.15 mg/min. Using these data, the default value for contact rate is set at 5.0 mg/minute.
Release duration	1 min	I.e. "spray" duration
Bathroom cleaning spray: spraying the shower walls[a)]		
Frequency	52 year^{-1}	Based on two studies, the bathroom walls is cleaned once a week
Inhalation, spray model		
Spray duration	1.5 min	The calculated 75th percentile for the spraying is derived from one study (14.3 sec. per m^2). For an area of 6.4 m^2, the extrapolated spraying time is 1.5 minutes.
Exposure duration	25 min	Estimate
Mass generation rate	0.39 g/sec	The default value for the mass generation rate of trigger sprays is set at 0.78 g product/sec. As it is assumed that active spraying occurred for a period of 0.75 min during a time span of 1.5 min, the default value mass generation rate is 0.39 g/sec.
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.1 g/g	Based on the general composition, it is assumed that the non-volatile part in bathroom cleaning sprays is about 10%; the default value weight fraction non-volatile is set at 0.1 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	100 µm (0.6)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	46 mg/min	See Table 11.2.2.1.
Release duration	1.5 min	I.e. spray duration
Bathroom cleaning spray: cleaning the shower walls[a)]		
Frequency	*52 year^{-1}*	*See "Bathroom cleaning spray: spraying the shower walls"*
Inhalation, evaporation from constant surface		
Exposure duration	25 min	Estimate
Product amount	30 g	On study gives an amount for surface spray from minimal 5 to maximal 30 gram. The average mass generation rate is set at 0.39 g/s with a spray duration of 90 sec. Therefore, the amount for spraying is 0.39 g/s x 90 s = 35.1 g; the amount on the surface is estimated at 85% of 35.1 g and is 30 gram, which is set as default value.
Release area	6.4 m^2	The walls of a shower cubicle with an area of 0.80 m (width) x 2.0 m (height) x 4 = 6.4 m^2.
Application duration	20 min	based on different studies
Mol. weight matrix	36 g/mol	Assuming that the water fraction is 0.5, the molecular weight matrix is 18 g/mol / 0.5 = 36 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.3 g	It is assumed that 1% of the product amount gives dermal exposure and 1% of 30 g product is 0.3 g
Exposure time, diffusion through skin	20 min	I.e. application duration

	Default Value	Comments
Bathroom cleaning liquid (containing acids and used to descaling): mixing and loading		
Frequency	4 $year^{-1}$	Estimate
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	See "Laundry liquid: filling the washing machine"
Product amount	500 g	See "Laundry liquid: filling the washing machine"
Room volume	1 m^3	See "Laundry powder: filling the washing machine"
Release area	0.002 m^2	See "Laundry powder: filling the washing machine"
Application duration	0.3 min	Estimation
Mol. weight matrix	26 g/mol	Assuming that the water fraction is 0.7, the molecular weight matrix is 18 g/mol / 0.7 = 26 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.010 g	See "Laundry powder: filling the washing machine"
Exposure time	0.75 min	See "Laundry powder: filling the washing machine"
Bathroom cleaning liquid (containing acids and used to descaling): cleaning the shower walls[a)]		
Frequency	4 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	25 min	Estimate
Product amount dilution	260 g	The amount, which is used for cleaning, is estimated at 40 ml of the diluted product per m2. For 6.4 m2, an amount of 260 ml or 260 gram of the diluted product is required for cleaning. Only the amount on the walls of the shower cubicle is taken into account for the default.
Weight fraction dilution	W_f / 45	Dilution 45 x. Per 2 litres wash water volume, 44 g bathroom cleaner is used, which gives a dilution of 45. The weight of the suds is the weight fraction of the product divided by the dilution factor (W_f / 45).
Release area	6.4 m^2	See "Bathroom cleaning spray: cleaning the shower walls"
Application duration	20 min	See "Bathroom cleaning spray: cleaning the shower walls"
Mol. weight matrix	18 g/mol	Matrix is water
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Weight fraction dilution	W_f / 45	Per 2 litres wash water volume, 44 g bathroom cleaner is used, which gives a dilution of 45. The weight of the suds is the weight fraction of the product divided by the dilution factor (W_f / 45).
Product amount dilution	19 g	Skin layer is 0.01 cm
Concentration dilution (diffusion through skin)	W_f /45 g/cm^3	Density water 1 g/cm^3
Exposure time	20 min	I.e. application duration
Toilet cleaner, acid and bleach[e)]		
Frequency		
Acid cleaner	260 $year^{-1}$	One study found a mean frequency of 0.3 day^{-1} which equals 2.1 $week^{-1}$. The calculated 75th percentile is 0.708 day^{-1} or 5.0 $week^{-1}$
Bleach	120 $year^{-1}$	The same study found a mean frequency of 7 times a month with a 75th percentile of 10 $month^{-1}$ or 120 $year^{-1}$.
Inhalation, evaporation from constant surface		
Exposure duration	3 min	Estimate
Product amount dilution	1000 g	Acid cleaner & bleach. One study found an average amount of 40 gram undiluted toilet cleaner with a 75th percentile of 55 gram. For cleaning the toilet with bleach the average amount was 55 g which gives a 75th percentile of 80 gram. The total amount of toilet cleaner and water in the toilet pan is estimated at 1 litre
Weight fraction dilution		
Acid cleaner	W_f / 18	Dilution 18x
Bleach	W_f / 12	Dilution 12x
Release area	0.075 m^2	For the release area, it is assumed that evaporation takes place from the toilet pan. The area is estimated at 750 cm^2.
Application duration	2 min	In one study, the duration ranged from 10 to 150 seconds. For application duration, the default value is set at 2 min.
Mol. weight matrix	18 g/ mol	Matrix is water

	Default Value	Comments
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount dilution	2.2 g	Skin layer 0.01 cm
Weight fraction dilution		
Acid cleaner	W_f / 18	Dilution 18x
Bleach	W_f / 12	Dilution 12x
Concentration dilution (diffusion through skin)		
Acid cleaner	W_f / 18	Density 1 g/cm^3
Bleach	W_f / 12	Density 1 g/cm^3
Exposure time	3 min	Based on two studies
Toilet rim cleaner[e)]		
Frequency	365 $year^{-1}$	Every day
Inhalation, constant rate		
Exposure duration	1440 min	I.e. 24 hours
Product amount		
Solid	30 g	Product information
Liquid	70 g	For a liquid toilet rim cleaner, containing 55 ml fluid (product information) with an estimated density of 1.3 g/cm^3, the amount is about 70 g.
Emission duration		
Solid	43200 min	Assuming that a toilet block of 30 gram can last for 30 days (product information), the default value for emission duration is set at 43200 minutes.
Liquid	86400 min	As it is assumed that a liquid product can last for 60 days, the emission duration is set at 86400 minutes
Inhalation rate	9 L/min	Rest
Floor cleaning liquid: cleaning[c)]		
Frequency	104 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Default
Product amount dilution	880 g	When cleaning a surface, the amount of solution which is left on the cleaned surface is estimated at 40 ml of the diluted product per m2. For 22 m2, an amount of 880 ml or 880 gram is left on the surface.
Weight fraction dilution	W_f / 20	The concentration used in a solution of combined floor products ranges from 0.5% to 2.5%). Floor cleaners are applied in a dilution of 0.5% to 5.0%). The latter is taken as concentration for the diluted product; for making a 5 litres cleaning solution, an amount of 250 gram is needed; this value is also given in the production information of linoleum cleaners. The dilution is then 20 times.
Release area	22 m2	Living room
Application duration	30 min	Estimate
Mol. weight matrix	18 g/mol	Matrix is water
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Weight fraction dilution	W_f / 20	See "Inhalation"
Product amount dilution	19 g	Skin layer 0.01 cm
Concentration dilution (diffusion through skin)	W_f /20 g/cm^3	Density water 1 g/cm^3
Exposure time	30 min	I.e. application duration
Floor mopping systems[c)]		
Frequency	104 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Default
Product amount	245 g	One study has found that for an area of 60 x 60 cm, the amount sprayed was 3.35 g with a calculated 75^{th} percentile of 4.016 g. Thus, to clean an area of 22 m2 an amount of 245 g is needed.
Release area	22 m^2	Living room
Application duration	30 min	Estimate
Mol. weight matrix	22 g/mol	The fraction of water in the product is estimated at 0.8. For the molecular weight matrix, the default value is 18 g/mol / 0.8 = 22 g/mol

	Default Value	Comments
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.25 g	Dermal exposure occurs when the pad is taken of the mop head and afterwards. The exposure duration for dermal exposure is set at 3 min. It is assumed that 10% of the used amount remains in the pad i.e. 24.5 g and that 1% of this amount contacts the skin resulting in a product amount of 0.25 gram.
Exposure time	3 min	Estimate. See "Product amount – dermal"
Floor polish (water based)[c)]		
Frequency	2 $year^{-1}$	Product information supported by two studies
Inhalation, evaporation from increasing area		
Exposure duration	90 min	After polishing the floor, it is assumed that the user will leave the room (product information).
Product amount	550 g	For wax or for floor polish parquet / linoleum, the product information gives that 1 litre product is sufficient for 40 m2. For polishing the floor area of the living room, the product amount is estimated at 550 gram for 22 m2
Release area	22 m^2	Living room
Application duration	90 min	For use duration, one study gave a 75^{th} percentile of 90 minutes which is set as default value.
Mol. weight matrix	22 g/mol	Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	430 cm2	One hand: ½ area hands
Product amount	5.5 g	1% of 550 g product
Exposure time	90 min	See "Exposure duration – inhalation"
Carpet cleaning liquid: mixing and loading		
Frequency	0.5 $year^{-1}$	Based on one study and the product information
Inhalation, evaporation from constant surface		
Exposure duration	0.75 min	For mixing and loading 60 g all-purpose cleaner in 5 litres water, an exposure duration of 0.75 minutes is given under "all-purpose cleaner liquid: mixing and loading". For the mixing and loading of 500 ml carpet cleaner in 10 litres water, the exposure duration is also set 0.75 minutes.
Product amount	500 g	See "Laundry liquid: filling the washing machine"
Room volume	1 m^3	See "Laundry liquid: filling the washing machine"
Release area	0.002 m^2	See "Laundry liquid: filling the washing machine"
Application duration	0.3 min	For mixing and loading 60 g all-purpose cleaner in 5 litres water, application duration of 0.3 minutes is given in "all-purpose cleaner liquid: mixing and loading"
Mol. weight matrix	36 g/mol	Assuming the product contains 50% water, the molecular weight matrix is 18 g/mol / 0.5 = 36 g/mol
Dermal, instant application		
Exposed area	215 cm2	One palm: ¼ area hands
Product amount	0.010 g	See "Laundry liquid: filling the washing machine"
Exposure time	0.75 min	I.e. exposure duration
Carpet cleaner liquid: manual cleaning of fitted carpet[c)]		
Frequency	0.5 $year^{-1}$	See "Carpet cleaning liquid: mixing and loading"
Inhalation, evaporation from increasing area		
Exposure duration	110 min	When the whole area of the carpet is cleaned, the user leaves the room. So, the exposure duration is the same as the application duration. For a thorough cleaning of carpet the use duration and exposure duration are estimated at 5 minutes per m2. Thus, for 22 m2 carpet the cleaning duration is 110 minutes.
Product amount dilution	10 000 g	The amount for carpet and upholstery cleaner is given as 500 ml for 15–20 m2 (product information). This quantity should be diluted to 10 litres; therefore, the maximal amount of the diluted cleaner is 10 000 ml / 22 m2 = 450 ml /m2. Foam cleaning and spray extraction leave up to 0.5 l cleaning solution / m2 carpet behind, requiring a drying time of up to 4 days. For (diluted) product amount the default value is set at 2200 ml.
Weight fraction dilution	W_f / 20	The weight fraction must be divided by the dilution factor, which is 20 times (500 ml in 10 litres).
Release area	22 m^2	Living room
Application duration	110 min	See "Exposure duration"
Mol. weight matrix	18 g/mol	Matrix is water

	Default Value	Comments
Dermal, instant application		
Exposed area	860 cm2	Area hands
Weight fraction dilution	W_f / 20	See "Weight fraction dilution – inhalation"
Product amount dilution	27 g	it is assumed that 0.27% of the applied stain ends up on the skin. For cleaning 22 m2 carpet 10 litres solution is needed; 0.27% equals 27 ml diluted carpet cleaner. The default value for product amount is set at 27 g.
Concentration – diffusion through skin	W_f / 20	Density 1 g/cm^3
Exposure time	110 min	See "Exposure duration – inhalation"
Carpet powder: scattering[c)]		
Frequency	0.5 year^{-1}	See "Carpet cleaning liquid: mixing and loading"
Inhalation, spray model		
Spray duration	22 min	Estimate
Exposure duration	22 min	Estimate
Mass generation rate	1.7 g/ sec	For cleaning the carpet, an amount of 50–100 g per m2 is given (product information). It is assumed that 2200 gram is necessary for dusting the fitted carpet of the living room. If 100 g is scattered in one minute, 2200 g of powder is scattered in 22 min. and the mass generation rate is 100 g/min = 1.7 g/sec.
Airborne fraction	0.2	No available data. See Table 11.2.2.1. "Trigger sprays"
Weight fraction non-volatile	1 g/g	Product
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1. "Trigger sprays"
Initial particle distribution Median (CV)	75 (0.6)	Based on one study
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1. "Trigger sprays"
Dermal, constant rate		
Contact rate	5.0 mg/min	In one study, the dermal exposure on hands and forearms ranges from 0.4 to 4.18 mg/min with a 75th percentile of 2.83 mg/min. The dermal exposure for legs, feet and face ranges from 0.22 to 6.56 mg/min with a 75th percentile of 2.15 mg/min. Using these data, the default value for contact rate is set at 5.0 mg/minute.
Release duration	22 min	I.e. "spray" duration
Uptake fraction	1	Potential dose
Carpet powder: post- application		
Frequency	14 year^{-1}	It is assumed that a child (default 10.5 months) crawls over the cleaned surface for 1 hour a day during a 14-day period
Body weight	8.69 kg	Child 10.5 months
Dermal, rubbing off		
Transfer coefficient	0.6 m^2/hr	The "transfer coefficient" is a quantification of the transfer of powder from the carpet surface to human skin per unit time as e.g. a child is crawling across a treated carpet, wiping some of the powder. For infants aged 6 months to 1–1.5 years, an assumed mean dermal transfer coefficient of 0.6 m2/ hr is given
Dislodgeable amount	3 g/m^2	For transfer efficiency for dried fluid, studies range between 3% (painted wood, MDF) to 60% (brown rough glazed tile). Based on these studies, the default value for dislodgeable fraction is set at 30%. It is assumed that after vacuuming 10% of the used amount settles on the carpet from which a certain fraction is dislodgeable. If 2200 g of carpet powder is scattered onto 22 m2, the dislodgeable product amount will be 100 g/ m2 x 0.1 (residual fraction) x 0.3 (dislodgeable fraction) = 3 g product/m2. Thus, the dislodgeable amount of carpet powder is 3 g/ m2.
Contact time	60 min	It is assumed that a child (default 10.5 months) crawls over the cleaned surface for 1 hour a day during a 14-day period
Rubbed surface	22 m^2	Living room
Exposed area	1170 cm^2	Infant surface area exposed is calculated based on a child wearing a short-sleeved shirt and a napkin, and no socks or shoes. The exposed area considered is, therefore, hands, feet, fore-arms and lower legs. The body part percentages of total surface area of exposed body surface area are for hands and feet 5.3% and 7.1%, respectively, for forearms and lower legs the percentages are 6.2% and 8.2%, respectively. The total exposed body part percentage is 26.8%, the total surface area body is 4370 cm^2, and as a result, the exposed area is 1170 cm^2.
Oral, direct intake		
Amount ingested	10% of the external dermal exposure	It is assumed that 10% of the used amount settles on the carpet. It is assumed that 50% of the product that ends up on the hands is taken in orally. This means that via hand-mouth contact 10% of the calculated external dermal exposure is ingested and that the internal dermal exposure is 90% of the calculated external dermal exposure.
Carpet spot removers		
Frequency	10 year^{-1}	Based on one study where the 75th percentile of frequency was 10 times a year
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.07 g	The default value for amount is set at 7 g (based on product information). Worst-case is estimated that 1% of the product amount contacts the skin; i.e. 0.07 g
Exposure time	10 min	Estimate

	Default Value	Comments
Furniture polish: manually rubbing a cupboard[c)]		
Frequency	1 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Estimate
Product amount	550 g	For wax or for floor polish parquet, the product information gives that 1 litre product is sufficient for 40 m2. Treating parquet or a cupboard is comparable; therefore, for polishing the cupboard surface, the product amount is estimated at 550 gram for 22 m2.
Release area	22 m^2	The cupboard measures 1.2 m (width) x 1.9 m (height) x 0.6 m (depth) and it has 4 shelves. Thus, an area of 22 m2 is treated with undiluted furniture polish
Application duration	90 min	Based on the 75th percentile in one study
Mol. weight matrix	272 g/mol	For products containing oil or wax, the density is about 0.8 g/ cm^3. Assuming that turpentine is a solvent in these products, fraction 0.5 and Mw 136, the molecular weight matrix is calculated as follows: 136 / 0.5 = 272 g/mol
Dermal, instant application		
Exposed area	430 cm^2	One hand: ½ area hands
Product amount	5.5 g	1% of 550 g product
Exposure time	90 min	I.e. application duration
Leather furniture spray: spraying a leather sofa[c)]		
Frequency	1 $year^{-1}$	Estimate
Inhalation, spray model		
Spray duration	3 min	Estimate
Exposure duration	240 min	Estimate
Mass generation rate	0.75 g/sec	See Table 11.2.2.1.
Airborne fraction	1 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.1 g/g	Based on the general composition, it is assumed that the non-volatile part in furniture polish spray is about 10%; the default value weight fraction non-volatile is set at 0.1 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	25 µm (0.4)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	100 mg/min	See Table 11.2.2.1.
Release duration	3 min	I.e. spray duration
Glass cleaner: spraying[c)]		
Frequency	365 $year^{-1}$	Estimate, 1 day^{-1}
Inhalation, spray model		
Spray duration	0.7 min	For spraying the default value is 14.3 sec/m2. Thus, for an area of 3 m2 the spraying time is 43 sec or 0.7 min.
Exposure duration	240 min	Estimate
Mass generation rate	0.78 g/sec	See Table 11.2.2.1.
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.05 g/g	Based on the general composition, it is assumed that the non-volatile part in glass cleaning sprays is about 5%; the default value weight fraction non-volatile is set at 0.05 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	100 µm (0.6)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	46 mg/min	See Table 11.2.2.1.
Release duration	0.7 min	I.e. spray duration

	Default Value	Comments
Glass cleaner: cleaning		
Frequency	365 year^{-1}	Estimate, day^{-1}
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.29 g	The sprayed amount is the mass generation rate multiplied with the spraying time i.e. 0.78 g/s x 43 s = 33.5 g. The amount on the surface is estimated at 85% of 33.5 g i.e. 28.5 gram. Worst-case is estimated that 1% of the product amount contacts the skin i.e.0.29 g.
Exposure time	6 min	For cleaning the default value is 110 sec/m2. Thus, for an area of 3 m2 the cleaning time is 330 sec or 5.5 min. The default for exposure time is set at 6 minutes.
Oven cleaner, trigger spray: spraying[b)]		
Frequency	26 year^{-1}	Based on three studies – 75th percentiles
Inhalation, spray model		
Spray duration	0.5 min	One study found for an area of 60 x 60 cm a used amount of 3.35 g with a calculated 75th percentile of 4.016 g and a maximum amount of 4.8 g. As default value for cleaning the oven twice the maximum amount is taken i.e. 26.7 g/m2; so, for an area of 0.9 m2 an amount of 24 g is needed. The active spraying time is amount used divided by mass generation rate i.e. 24 g / 0.78 g/s = 30.8 sec = 0.5 min, which is set as default value for spray duration.
Exposure duration	60 min	Estimate
Mass generation rate	0.78 g/sec	See Table 11.2.2.1.
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.1 g/g	It is assumed that oven cleaning trigger sprays have more or less the same composition as oven cleaning liquids which contain surfactants, builders and bases (0–15%, see above). It is assumed that the non-volatile part in oven cleaners is about 10%; the default value weight fraction non-volatile is set at 0.1 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	100 µm (0.6)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	46 mg/min	See Table 11.2.2.1.
Release duration	0.5 min	I.e. spray duration
Oven cleaner, trigger spray: cleaning		
Frequency	26 year^{-1}	See "Oven cleaner, trigger spray: spraying"
Dermal, instant application		
Exposed area	430 cm^2	One hand: ½ area hands
Product amount	0.20 g	The sprayed amount is 24 g. The amount on the surface is estimated at 85% of 24 g i.e. 20.4 gram. Worst-case is estimated that 1% of the product amount contacts the skin i.e. 0.2 g.
Exposure time	20 min	Maximum use duration
Metal cleaners: cleaning[b)]		
Frequency	6 year^{-1}	Estimate, every two months
Inhalation, evaporation from increasing area		
Exposure duration	60 min	Estimate
Product amount	10 g	Estimate
Release area	1.71 m^2	Estimate
Application duration	10 min	Estimate
Mol. weight matrix	22 g/mol	Assuming that the water fraction is 0.8, the molecular weight matrix is 18 g/mol / 0.8 = 22 g/mol
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.10 g	1% of 10 g product
Exposure time	10 min	I.e. application duration

	Default Value	Comments
Shoe polish spray[f]		
Frequency	8 $year^{-1}$	Based on the 75th percentile from one study
Inhalation, spray model		
Spray duration	1.2 min	One study gives a 75th percentile of 284 g for used amount per year i.e. a used amount of 36 gram per event. With a mass generation rate of 0.5 g/s, the calculated spray duration is 72 sec or 1.2 min.
Exposure duration	5 min	Estimate
Mass generation rate	0.5 g/sec	The default value for the mass generation rate of sprays is 1.5 g/s. It is assumed that the use duration, the time during which the spraying takes place, is three times as long as the actual spraying time. The mass generation rate is set at 0.5 g/s.
Airborne fraction	0.2 g/g	See Table 11.2.2.1.
Weight fraction non-volatile	0.05 g/g	Based on the general composition, it is assumed that the non-volatile part in shoe polish sprays is about 5%; the default value weight fraction non-volatile is set at 0.05 g/g.
Density non-volatile	1.8 g/cm^3	See Table 11.2.2.1.
Initial particle distribution Median (CV)	25 µm (0.4)	See Table 11.2.2.1.
Inhalation cut-off diameter	15 µm	See Table 11.2.2.1.
Dermal, constant rate		
Contact rate	100 mg/min	See Table 11.2.2.1.
Release duration	1.2 min	I.e. spray duration
Shoe cream		
Frequency	26 $year^{-1}$	The frequency is estimated at once a fortnight i.e. 26 times a year. It is assumed that one uses shoe polish cream more frequently than shoe polish spray
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.10 g	1% of 10 g product
Exposure time	20 min	Estimate

a) Bathroom – see Table 11.2.2.2.

b) Kitchen – see Table 11.2.2.2.

c) Living room – see Table 11.2.2.2.

d) Non-specified room – see Table 11.2.2.2.

e) Toilet – see Table 11.2.2.2.

f) Garage – see Table 11.2.2.2.

Source: Modified from the *Cleaning Product Fact Sheet*, RIVM (2006c).

11.1.3 Do-it-yourself products

In the *Do-it-yourself Products Fact Sheet*, RIVM (2007a), do-it-yourself (DIY) products are classified into 26 categories, which are characterized according to the type of use and exposure. DIY tasks are carried out mainly during leisure time. According to data from Statistics Netherlands (2005), approximately 25% of the Dutch population (age over 14 years) spends one to four hours per week on DIY tasks. Furthermore, Statistics Netherlands specifies that 6% of that population spends over five hours per week on DIY tasks during their leisure time (RIVM, 2007a).

Like in the two previous described Fact Sheets, default models and default parameter values are proposed for each product category. The default values provided in the *Do-it-yourself Products Fact Sheet*, RIVM (2007a), are mainly based on an observational study by RIVM by Magré from 2005 (Magré, 2005). However, the observations in this study were quite low. Therefore, the information gathered in the study can be used as preliminary data which can be considered indicative for consumer use of DIY products.

The exposure models are also thoroughly described in this Fact Sheet and will only shortly be mentioned under each product. The more complicated model "spraying" is already described in the two previous sections. A few general default values will be described here:

- *Non-specified room*: Unless it is obvious or specified where the task will be performed, a "non-specified room" will be considered. The non-specified room has a volume of 20 m^3 with a ventilation rate of 0.6 h^{-1}. The temperature is usually that of the room, which is set at 20° C and the standard room height is 2.5 m (RIVM, 2007a)
- *The user:* Users of DIY products are both men and women, (although men use these items more often. The average size of body parts for adults is used here from General Fact Sheet (RIVM, 2006a). The body weight of the adult user is set at 65 kg as a default. It is most likely that individuals will be dermally exposed to their hands while working with DIY products, where both intentionally or accidental contact may occur. The surface area for both hands is set at 860 cm^2 by default, whereas sometimes only one hand or one palm will be taken as exposure area. These surface areas relate to the total surface area by factor 0.5 or 0.25, respectively. Fingertips are quite often used to smooth joints made from sealants. Their surface area is set at 1 cm^2 per fingertip (RIVM, 2007a)
- *Molecular Weight Matrix:* DIY products are in most cases mixtures of compounds; in the case of a mixture the evaporation is not only determined by the compound of interest, but also by the other constituents. The molecular weight of the matrix (or: mol. weight matrix) is the weighted average of the matrix, which contains the chemical of interest. The mol. weight matrix parameter is used to correct for the evaporation rate since it describes the average mol.

weight of the rest of the total product (the product minus the compound of interest). This parameter can be left blank when the product purity is 100%. The exact composition is not known in most cases. When the composition is unknown the mol. weight matrix will be set at 3000 g/mol as a worst case value when nothing else is stated. Roughly, inserting this value in the evaporation model will result in an estimation of a product in its pure form (RIVM, 2007a)

Table 11.7 presents default values of DIY products from the *Do-it-yourself Products Fact Sheet*, RIVM (2007a).

Table 11.7: Default Values on Do-it-yourself Products

	Default Values	Comments
Tube glue		
Frequency	1 week^{-1}	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Assuming that a person stays in the room after use
Application duration	10 min	Estimate
Product amount	9 g	Estimate
Release area	200 cm^2	According to the directions for use of the products per 100 ml, a surface of 0.2 m^2 can be treated. The amount of glue, set as default at 10 ml per 0.02 m^2, will, for this situation, be less, a product amount of 9 g is calculated and a product density is 0.9 g/cm^3.
Dermal, instant application		
Surface area	2 cm^2	Two fingertips
Product amount	0.08 g	Estimate based on one study
Bottled glue: universal/wood glue.		
Frequency	1 week^{-1}	Hobby use
Inhalation, evaporation from increasing area		
Exposure duration	240 min	It is expected that the individual will stay in the room for four hours in total.
Application duration	20 min	Estimate
Product amount	10 g	Estimate
Release area	400 cm^2	For the hobby task it was estimated that approximately 10 gram is needed (personal estimation). This relates to a surface area of 0.04 m2 according to product information.
Dermal, instant application		
Surface area	2 cm^2	Two fingertips
Product amount	0.08 g	Estimate based on one study
Bottled glue: construction glue		
Frequency	2 year^{-1}	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Assembling a closet takes four hours (=exposure duration) of which 30 minutes actual gluing.
Application duration	30 min	See “exposure duration”
Product amount	250 g	Product information – to treat an area of 1 m^2
Release area	1 m^2	Estimate
Dermal, instant application		
Surface area	215 cm^2	Surface of one hand palm
Product amount	0.25 g	Estimate
Super glue		
Frequency	1 month^{-1}	Estimate
Inhalation, evaporation from constant area		
Exposure duration	240 min	The subject stays in the room after use
Application duration	5 min	Estimate
Product amount	0.5 g	Based on one study
Release area	2 cm^2	Estimate based on product information
Dermal, instant application		
Surface area	2 cm^2	Two fingertips
Product amount	25 mg	Half a droplet size is considered (25 mg) as default

	Default Values	Comments
Two-component glue: mixing and loading		
Frequency	3 $year^{-1}$	Estimate
Inhalation, evaporation from constant release area		
Exposure duration	5 min	Estimate
Application duration	5 min	Estimate
Product amount	20 g	Product information: gluing a large broken vase
Room volume	1 m^3	"Room volume" is interpreted here as personal space: a small area of 1 m^3 around the user. A small area around the user is relevant for the inhalation exposure of the user for the short use duration in which the treatment takes place.
Release area	20 cm^2	Evaporation takes place from a constant surface area, i.e. the mixing cup. The surface area is estimated at 20 cm^2.
Dermal, instant application		
Surface area	2 cm^2	Two fingertips
Product amount	50 mg	One drop
Two-component glue		
Frequency	3 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	The subject stays in the room after use
Application duration	30 min	Estimate
Product amount	20 g	Product information: gluing a large broken vase
Release area	20 cm^2	Evaporation takes place from a constant surface area, i.e. the mixing cup. The surface area is estimated at 20 cm^2.
Dermal, instant application		
Surface area	43 cm^2	Assuming that approximately 20% of one palm (quarter of the total surface of the hands = 215 cm^2) is exposed, provides a surface area of 43 cm^2.
Product amount	0.1 g	The dermal load is not high, because relatively low amounts are used. Assuming that two drops are spilled, a dermal load of 0.1 g can be derived.
Two component parquet glue: mixing and loading		
Frequency	3 day^{-1}	3 day^{-1}, once every 8 years
Inhalation, evaporation constant release area		
Exposure duration	10 min	Estimate
Application duration	10 min	Estimate
Product amount	7 kg	The product amount required for this task is very high (22 kg; derived from consumption rate of 1 kg/m^2 and surface area of 22 m^2). The mixing and loading step will be repeated approximately three times, because the product amount is simply too much to handle in one step.
Room volume	1 m^3	See "Two-component glue: mixing and loading"
Release area	320 cm^2	Surface bucket
Dermal, instant application		
Surface area	215 cm^2	¼ of two hands
Product amount	200 mg	Estimate
Parquet glue: gluing on surface		
Frequency	*1/8 $year^{-1}$*	*Once in eight years*
Inhalation, evaporation constant release area		
Exposure duration	480 min	Estimate, eight hours
Application duration	480 min	Estimate, eight hours
Product amount	22 kg	Product information
Room volume	58 m^3	Living room
Ventilation rate	0.5 h^{-1}	Living room
Release area	1 m^2	The release area is set equal to the surface area that can be treated per interval. It is assumed that an individual treats 1 m^2 per interval. After that the surface is covered and the exposure will be negligible compared with the newly treated surface. These steps are repeated until the task is completed, resulting in 22 repetitions. The inhalation exposure is described by evaporation of the total amount and not the adjusted amount from a constant surface area, i.e. 1 m^2. This simplification of the model is necessary, because otherwise depletion of the source can occur.

	Default Values	Comments
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	30 mg/min	Default value for downward or to the side painting
Release duration	480 min	Estimate, eight hours
Parquet glue: floating parquet		
Frequency	1/4 $year^{-1}$	Once every four years
Inhalation, evaporation constant release area		
Exposure duration	240 min	Estimate, four hours
Application duration	240 min	I. e. exposure duration
Product amount	750 g	According to the product information 1 kg is sufficient to cover 30 m^2. For an area of 22 m^2 it is assumed that 750 grams of glue is used.
Room volume	58 m^3	Living room
Ventilation rate	0.5 h^{-1}	Living room
Release area	1 m^2	It is assumed that 1 m^2 is treated per interval; the effective release area is then 1 m^2. This interval is repeated 22 times to complete the task. See "Parquet glue: gluing on surface"
Dermal, instant application		
Surface area	110 cm^2	50% of one hand palm
Product amount	0.5 g	Estimate
Carpet glue		
Frequency	1/4 $year^{-1}$	Once every four years
Inhalation, evaporation constant release area		
Exposure duration	75 min	Assuming that the carpet is already cut to size and is only moved to fit
Application duration	75 min	I.e. exposure duration
Product amount	9 kg	According to product information an average of 1 kg carpet glue per 2.5 m^2 is used for laying carpets, providing a total product amount of approximately 9 kg carpet glue
Room volume	58 m^3	Living room
Ventilation rate	0.5 h^{-1}	Living room
Release area	4 m^2	It is assumed that 4 m^2 per interval can be treated, which will take 15 minutes per effort
Dermal, constant rate		
Surface area	110 cm^2	50% of one hand palm
Contact rate	30 mg/min	See "Parquet glue: gluing on surface"
Release duration	75 min	See "exposure duration"
Tile glue: mixing and loading		
Frequency	5 day^{-1}	Once every 2 years
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	0.33 mg/min	Default value for large tasks
Release duration	1.33 min	Estimate
Tile glue		
Frequency	0.5 $year^{-1}$	Estimate
Inhalation, evaporation constant release area		
Exposure duration	360 min	Estimate, six hours
Application time	360 min	Estimate, six hours
Product amount	15 kg	Product information. The use of glue is on average 1–2 kg/m^2. Assuming an average use of 1.5 kg/m^2, this yields a total amount of 15 kg tile glue to be used on 10 m^2.
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Release area	1 m^2	This is the surface a subject is assumed to cover per interval.
Dermal, constant rate		
Surface area	430 cm^2	Two hand palms; 50% of both hands
Contact rate	30 mg/min	See "Parquet glue: gluing on surface"
Release duration	360 min	Estimate
Wall paper glue: mixing and loading		
Frequency	0.5 $year^{-1}$	Estimate; once every two years
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	0.033 mg/min	Default value for small tasks
Release duration	1.33 min	Estimate

	Default Values	Comments
Wall paper glue		
Frequency	0.5 $year^{-1}$	Estimate; once every two years
Dermal, constant rate		
Surface area	860 cm^2	Both hands. The spreading of the glue, folding and hanging of wall paper will cause spills on both hands. The dermal load can be significant, depending on how the subject handles the wall paper. Since wall paper glue is not considered harmful and easy to remove afterwards, subjects tend to be more careless.
Contact rate	30 mg/min	See "Parquet glue: gluing on surface"
Release duration	240 min	Estimate, six hours
Hot melt adhesive		
Frequency	1 $month^{-1}$	Estimate; once per month. Gluing the soles of the shoes with a hot melt adhesive
Inhalation, instant release		
Exposure duration	25 min	In total, an application duration of 25 minutes will be taken into account which is spread over a longer period of time (gluing occurs with intervals).
Product amount	65 g	One glue bar
Dermal, instant application		
Surface area	43 cm^2	20% of a hand palm
Product amount	100 mg	Estimate. The dermal load will be low, because the glue is still solid at room temperature. The glue is more or less rubbed off the glue bar.
Glue spray		
Frequency	1 $month^{-1}$	Estimate; gluing a poster to a wall or door, or put in a frame
Inhalation, spray model		
Spray duration	170 sec	The surface of the poster is assumed to be 1.5 m^2. According to product information 300 ml (255 g; product density is 0.85 g/cm^3) is required to glue the poster. Using the mass generation rate from Table 11.2.2.1. (1.5 g/sec) provides a spraying duration of 170 seconds
Exposure duration	240 min	The exposure duration is the time that a person stays in the room duringand after the task
Mass generation rate	1.5 g/sec	See section 11.2.2. "Cleaning Products"
Airborne fraction	1 g/g	See section 11.2.2. "Cleaning Products"
Weight fraction non-volatile	0.16	Product information
Density non-volatile	1.3 g/cm^3	See section 11.2.2. "Cleaning Products"
Initial droplet distribution – median (CV)	40 µm (0.4)	See section 11.2.2. "Cleaning Products"
Inhalation cut-off diameter	15 µm	See section 11.2.2. "Cleaning Products"
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	100 mg/min	Default value for overhead painting with low viscosity products
Release duration	170 sec	See "spray duration"
Joint sealant		
Frequency	3 $year^{-1}$	Estimate; based on one study
Inhalation, evaporation from increasing area		
Exposure duration	45 min	Estimate; includes time of finishing up after use
Application duration	30 min	Estimate
Product amount	75 g	Estimate; silicon based sealant
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Release area	250 cm^2	5 m * 5 mm (joints between bathtub, shower cabinet, or washstands and wall)
Dermal, constant rate		
Surface area	2 cm^2	The dermal exposure area is the tip of one finger (1 cm^2). Due to the amount of surplus sealant the exposure area is set at 2 cm^2 instead of just the fingertip.
Contact rate	50 mg/min	Using the constant rate model the constant rate is calculated to be 50 mg/min (1.5 g divided by release duration of 30 min)
Release duration	30 min	See "application duration"

	Default Values	Comments
Assembly sealant		
Frequency	1 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	An application duration of 30 minutes is chosen here. The time a subject stays in the room after the DIY task is 4 hours which will be used in the default scenario.
Application duration	30 min	Estimate
Product amount	390 g	Product information
Release area	1.5 m^2	Estimate, sealing a wooden frame
Dermal, instant application		
Surface area	43 cm^2	20% of one hand palm
Product amount	0.5 g	Estimate
General filler from powder: mixing and loading		
Frequency	2 $year^{-1}$	Estimate
Inhalation		
Inhalation of dust	0.3 µg	Calculated by the contact rate of 0.25 µg/min and exposure duration of 1.33 min
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	0.033 mg/min	Default value for small tasks
Release duration	1.33 min	Estimate
General filler from powder[a)]		
Frequency	2 $year^{-1}$	Estimate
Dermal, instant application		
Surface area	430 cm^2	50% of both hands
Product amount	0.25 g	Filler is spilled on hands, while putting the filler in the hole. The spilled amount will be low, because working with fillers is relatively easy. The dermal load is estimated at 0.25 g, which is 0.1% (estimation) of the total product amount.
Exposure duration	15 min	Estimate
Large hole filler from powder: mixing and loading		
Frequency	1 $year^{-1}$	Estimate
Inhalation		
Inhalation of dust	0.3 µg	Calculated by the contact rate of 0.25 µg/min and exposure duration of 1.33 min
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	0.033 mg/min	Default value for small tasks
Release duration	1.33 min	Estimate
Large hole fillers[a]		
Frequency	1 $year^{-1}$	Estimate
Dermal, instant application		
Surface area	430 cm^2	One finger
Product amount	0.5 g	Estimate
Exposure duration	30 min	Estimate; application duration
Fillers/putty from tube		
Frequency	3 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Estimate, assuming that the subject stays in the room for 4 hours in total, the exposure duration will be 4 hours.
Application duration	20 min	Estimate
Product amount	40 g	It is estimated that this DIY task will require 40 grams to fill the holes.
Release area	200 cm^2	The surface area is determined by summing each cover of a screw hole (of an entire bookcase). This is estimated at 5 cm^2 per screw hole, assuming 40 screw holes; a total surface area of 200 cm^2 is provided.
Dermal, instant application		
Surface area	22 cm^2	5% of one hand
Product amount	0.05 g	Estimate

	Default Values	Comments
Two-component filler: mixing and loading		
Frequency	2 $year^{-1}$	Estimate
Inhalation, evaporation constant release area		
Exposure duration	5 min	Estimate
Application duration	5 min	Estimate
Product amount	200 g	Estimate
Room volume	1 m^3	"Room volume" is interpreted here as personal space: a small area of 1 m^3 around the user. A small area around the user is relevant for the inhalation exposure of the user for the short use duration in which the mixing takes place.
Release area	100 cm^2	Estimate
Dermal, instant application		
Surface area	2 cm^2	Two fingertips
Product amount	20 mg	Estimate
Two-component filler		
Frequency	2 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	Estimate
Application duration	30 min	Estimate
Product amount	200 g	Estimate
Release area	50 cm^2	The surface from which the chemicals can evaporate is estimated to be 50 cm^2 (5 x 10 cm^2) (Repairing all spots in the decayed wood of a window frame)
Dermal, instant application		
Surface area	22 cm^2	5% of one hand due to spills
Product amount	0.2 g	The dermal load is estimated at 0.2 g which is 0.1% (assumption) of the total product amount
Putty spray		
Frequency	1 $year^{-1}$	Estimate
Inhalation, spray model		
Spray duration	135 sec	For this task it is assumed that 200 g is required to cover a surface area of 500 cm^2. A mass generation rate of 1.5 g/sec provides spray duration of 135 seconds (rounded off number; 3x spraying to cover the scratches provides a spraying duration of 45 seconds).
Exposure duration	30 min	After completing the task the subject will leave the garage, making the total exposure duration half an hour.
Room volume	34 m^3	Garage
Ventilation rate	1.5 h^{-1}	Garage
Mass generation rate	1.5 g/sec	See section 11.2.2. "Cleaning Products"
Airborne fraction	1 g/g	See section 11.2.2. "Cleaning Products"
Weight fraction non-volatile	0.3	The weight fraction of nonvolatiles is estimated to be 30%, twice as high as for glue spray, because it is assumed that putty requires a higher percentage of solids
Density non-volatile	1.3 g/cm^3	See section 11.2.2. "Cleaning Products"
Initial droplet distribution – median (CV)	40 µm (0.4)	See section 11.2.2. "Cleaning Products"
Inhalation cut-off diameter	15 µm	See section 11.2.2. "Cleaning Products"
Dermal, constant rate		
Surface area	860 cm^2	Both hands
Contact rate	100 mg/min	Default value for overhead painting with low viscosity products
Release duration	135 sec (45 s*3)	See "spray duration"
Floor equalizer: mixing and loading		
Frequency	3 day^{-1}	3 day^{-1} once every 2 years. The product amount (25 kg) is not mixed all at once. Therefore the frequency of the mixing and loading process is three per task.
Inhalation		
Inhalation of dust	3.0 µg	Inhalation exposure to such large amounts was calculated by the rate of contact: 2.5 µg/min x exposure duration of 1.33 minutes yields an inhalation exposure of 3.0 µg.
Dermal, constant rate		
Surface area	430 cm^2	50% of both hands
Contact rate	0.33 mg/min	Default value for large tasks
Release duration	1.33 min	Estimate

	Default Values	Comments
Floor equalizer		
Frequency	0.5 year^{-1}	Estimate
Dermal, instant application		
Surface area	860 cm^2	Both hands
Product amount	2 g	Estimate
Exposure duration	30 min	Estimate
Wall plaster		
Frequency	0.2 year^{-1}	Estimate; once every five years
Dermal, constant rate		
Surface area	1900 cm^2	Hands and forearms
Contact rate	50 mg/min	Estimate
Release duration	120 min	Estimate
General coating on a floor		
Frequency	0.33 year^{-1}	Estimate; once per three years
Inhalation, evaporation from increasing area		
Exposure duration	60 min	Estimate; the person will not stay in the garage after application
Application duration	60 min	Estimate
Product amount	3 kg	The scenario is a garage with a surface area of 15 m^2. The consumption rate of the coating is according to product information 0.15 litre per square metre. In total 2.5 litres (3 kg using 1.2 g/cm^3) of coating is required for one layer
Room volume	34 m^3	Garage
Ventilation rate	1.5 h^{-1}	Garage
Release area	15 m^2	Garage
Temperature	15 °C	Estimate
Dermal, instant application		
Surface area	108 cm^2	50% of one hand palm
Product amount	0.25 g	Estimate; only due to spills
Gutter coating		
Frequency	0.1 year^{-1}	Estimate; once per 10 years
Dermal, instant application		
Surface area	430 cm^2	It is assumed that fingers on both hands will be exposed when the glass cloth is put in place. The surface area is set at half the area covered by the two hands (430 cm^2)
Product amount	0.25 g	The dermal load is estimated to be 250 mg due to the fact that the product will stick to one's hand. The dermal load is not related to the amount product used (=approx. 1 kg).
Exposure duration	240 min	I.e. application duration; half a working day
Paint remover		
Frequency	1 year^{-1}	Estimate; once a year
Inhalation, evaporation from increasing area		
Exposure duration	60 min	Estimate; i.e. application duration
Application duration	60 min	Estimate
Product amount	1 kg	The surface area is approximately 2 m^2 (one side of the door) for which 1 l is required (= 1 kg).
Release area	2 m^2	See "product amount"
Dermal, instant application		
Surface area	430 cm^2	Both hand palms
Product amount	0.5 g	Estimate; from pulps and remnants
Glue remover		
Frequency	1/4 year^{-1}	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	240 min	The total exposure duration is set at four hours, because after the task the subject will not stay in the same "room".
Application duration	240 min	The application duration is based on the pouring and spreading of the remover, the activation time, and the time needed to scratch off the old glue. The latter will consume a lot of time.
Product amount	2 kg	Product information;, it is assumed that the stairs are stripped of their carpet and carpet glue. The surface of the stairs is approximately 5 m^2. Using the product information (0.35 l/m^2) provides a product amount of about 2 kg.
Room volume	30 m^3	Estimate; stairs (large volume)
Ventilation rate	1.5 h^{-1}	Estimate
Release area	5 m^2	Estimate; surface of the stairs

	Default Values	Comments
Dermal, constant rate		
Surface area	230 cm^2	The fingers of both hands
Contact rate	30 mg/min	Default value for downward or to the side painting
Release duration	240 min	I.e. application duration
Wall paper remover: mixing and loading		
Frequency	0.5 $year^{-1}$	Estimate
Dermal, instant application		
Product amount on skin	10 mg/operation	As a default for 40 m^2 the total product amount is set at 3 litres of suspension (150 ml wall paper remover in 3 l lukewarm water, equal to approximately 3 kg; dilution factor = 20). The time needed to make the suspension is approximately five minutes. The 75^{th} percentiles for dermal exposure during mixing and loading are given for 1 litre and 2 litre containers i.e. 0.01 ml (undiluted product) per operation. A default for mixing and loading of wall paper remover of 0.01 ml per operation (=10 mg/operation) will be used.
Surface area	2 cm^2	Two fingertips. It is emphasized here that the dermal exposure results from liquid spills around the opening of the bottle and spatters of the product i.e. small product amount.
Wall paper remover		
Frequency	0.5 $year^{-1}$	Estimate
Dermal, instant application		
Surface area	1900 cm^2	The aqueous liquid easily runs down the hands and forearms. The dermal exposure area is therefore set at 1900 cm^2, which equals the surface area of both hands and forearms
Weight fraction dilution	0.2 * W_f	Dilution factor = 20
Product amount dilution	19 g	It is assumed that suspension spilled or run off from the sponge during use forms a layer on the skin of 1 mm. The volume on the skin is then 19 cm^3, which equals a product amount of 19 g (product density is assumed to be 1.0 g/cm^3)
Sealant/foam remover		
Frequency	5 $year^{-1}$	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	180 min	Estimate; includes the cleaning up after application
Application duration	120 min	Estimate
Product amount	100 g	No information is available on the rate of use of the product; therefore an estimated use of 100 ml (assuming a product density of 1.0 g/cm^3 provides 100 g)
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Release area	250 cm^2	From 5 m x 5 mm joint
Dermal, instant application		
Surface area	5 cm^2	The fingertips of one hand
Product amount	0.1 g	0.1% of the total amount used
Insulation foam – active agents (PU/MDI) and solvents		
Frequency	0.2 $year^{-1}$	Estimate; once per five years. A standard DIY task concerning insulation foam is the insulation of the attic to avoid heat loss and prevent draught
Inhalation, instant release		
Exposure duration	30 min	I.e. application duration
Application duration	30 min	Estimate
Total product amount	825 g	The product amount is 750 ml which equals to 825 g when 1.10 g/cm^3 is considered as product density (product information). One spray can provide up to 40 l of foam, which is considered sufficient to insulate the attic.
Room volume	57.5 m^3	In the General Fact Sheet (RIVM, 2006a) a surface area for the attic is provided: 23 m^2. Taking 2.5 m for the height of the attic provides 57.5 m^3
Ventilation rate	1.5 h^{-1}	Estimate
Dermal, instant application		
Surface area	1900 cm^2	Both hands and forearms
Product amount	0.25 g	Estimate; minimal amount

	Default Values	Comments
Joint colour		
Frequency	1 year^{-1}	Estimate
Inhalation, evaporation from increasing area		
Exposure duration	120 min	I.e. application duration
Application duration	120 min	Application and cleaning (i.e. removing surplus joint colour)
Product amount	100 g	Per litre product, 40–60 m^2 can be treated. A reasonable worst case considered for this product amount is 100 ml (= 100 g) for 4 m^2
Room volume	10 m^3	Bathroom
Ventilation rate	2 h^{-1}	Bathroom
Release area	4 m^2	Shower cabinet and walls
Dermal, instant application		
Surface area	1900 cm^2	Both forearms and hands (because water can run down one's arm)
Product amount	0.5 g	0.5% of the product

a) Inhalatory exposure is expected to be negligible, because the product does not contain constituents which are likely to evaporate except water.

Source: Modified from the Do-it-yourself Products Fact Sheet, RIVM (2007a).

11.1.4 Paint products

In the *Paint Products Fact Sheet*, RIVM (2007b), paint products are classified into product categories, which are drawn up according to the type product and the application method, that is, "Brush and roller painting" and "Spray painting". According to the *Paint Products Fact Sheet*, RIVM (2007b), there is a relationship between the type of paint, use duration and product amount. Spray cans with paint are usually applied during a short time. Latex wall paint is usually applied for large surfaces in larger quantities and the application duration will be relatively long. The quantity of paint used per unit of time when painting a chair or a window frame will be much smaller than when painting a lathed wall or varnish a floor. If paint is sprayed, aerosol particles are formed which can be inhaled, which may lead to inhalation exposure to non-volatile compounds present in the paint (RIVM, 2007b).

Several models and parameters have already been discussed in the previous sections. It is assumed that the body weight is 65 kg (default values for adults (RIVM, 2006a)) and the room temperature is 20° C. Table 11.8 presents default values for brush and roller painting and Table 11.9 presents default values for spray painting. For description of the parameters included in the spray model, see "cosmetics" and "cleaning products".

Table 11.8: Default Values for Brush and Roller Painting

	Default value	Comment
Brush / roller painting, solvent rich paint[a)]		
Frequency	1 $year^{-1}$	Usage 2 times a year one or a few days after each other; once per 2 years
Inhalation, evaporation from increasing area		
Exposure duration	132 min	The exposure duration is set at 1.1 times the application duration, to account for the clean-up time; it is assumed that the person leaves the room after application and cleaning up
Application duration	120 min	Estimate
Product amount	1000 g	For painting a wooden wall of 10 m^2, 0,833 l or 1000 g paint is necessary (paint coverage 12 m^2 / l, density 1.2 g/cm^3).
Release area	10 m^2	Room: 20 m^3; l x w x h = 4 x 2 x 2.5 m. The surface of the wooden wall is 4 x 2.5 = 10 m^2
Mol. weight matrix	300 g/mol	For solvent rich paint (45% solvent, Mw 140); the compound of interest is not the main solvent
Dermal, constant rate		
Contact rate	30 mg/min	Default value for downward painting and painting directed to the side; all paint products
Release duration	120 min	I.e. application duration
Brush / roller painting, high solid paint[a)]		
Frequency	1 $year^{-1}$	Usage 2 times a year one or a few days after each other, once per 2 years – based on two studies
Inhalation, evaporation from increasing area		
Exposure duration	132 min	See "Brush / roller painting, solvent rich paint"
Application duration	120 min	Estimate
Product amount	1300 g	For painting a wooden wall of 10 m^2, 1 liter or 1300 g paint is required (paint coverage 10 m^2 /l, density 1.3 g/cm^3)
Release area	10 m^2	Room: 20 m^3; l x w x h = 4 x 2 x 2.5 m. The surface of the wooden wall is 4 x 2.5 = 10 m^2
Mol weight matrix	550 g/mol	Default value for high solid paint (25% solvent, Mw 140); the compound of interest is not the main solvent
Dermal, constant rate		
Contact rate	30 mg/min	See "Brush / roller painting, solvent rich paint"
Release duration	120 min	I.e. application duration
Brush / roller painting, waterborne paint[a)]		
Frequency	1 $year^{-1}$	Usage 2 times a year one or a few days after each other, once per 2 years – based on two studies
Inhalation, evaporation from increasing area		
Exposure duration	132 min	See "Brush / roller painting, solvent rich paint"
Application duration	120 min	Estimate
Product amount	1250 g	For painting a wooden wall of 10 m^2, 1 liter or 1250 g paint is necessary (paint coverage 10 m^2 /l, density 1.25 mg/cm^3)
Release area	10 m^2	Room: 20 m^3; l x w x h = 4 x 2 x 2.5 m. The surface of the wooden wall is 4 x 2.5 = 10 m^2
Mol weight matrix	45 g/mol	Default value for waterborne paint (40% water, Mw 18); the compound of interest is not the main solvent
Dermal, constant rate		
Contact rate	30 mg/min	See "Brush / roller painting, solvent rich paint"
Release duration	120 min	I.e. application duration
Brush / roller painting, waterborne wall paint[a)]		
Frequency	2 $year^{-1}$	Estimate based on two studies
Inhalation, evaporation from increasing area		
Exposure duration	132 min	See "Brush / roller painting, solvent rich paint"
Application duration	120 min	Estimate
Product amount	3750 g	With 1 liter latex 6 m^2 can be painted. For painting two walls of in total 15 m^2, 2.5 liter or 3.75 kg paint is necessary (density 1.5 g/cm^3)
Mol. weight matrix	120 g/mol	Default value for wall paint, waterborne (15% water, Mw 18); the compound of interest is not the main solvent
Dermal, constant rate		
Contact rate	30 mg/min	See "Brush / roller painting, solvent rich paint"
Release duration	120 min	I.e. application duration

	Default value	Comment
Two-component paint: mixing and loading		
Frequency	1/3 year^{-1}	Estimate; once per three years
Inhalation, evaporation constant release area		
Exposure duration	5 min	Estimate
Application duration	5 min	Estimate
Product amount	NA	The product amount, the quantity of paint which is mixed and loaded, depends on the scenario which is chosen for the application of the two-component paint
Room volume	1 m^3	"Room volume" is interpreted here as "personal space": a small volume of 1 m^3 around the user. A small volume around the user is relevant for the inhalation exposure of the user, for the short use duration in which the treatment takes place
Ventilation rate	0.6 h^{-1}	The ventilation rate for an unspecified room is used, because no information is available on the ventilation rate near the user.
Release area	95 cm^2	Estimate
Mol. weight matrix	3000 g/mol	Default value for paint where the compound of interest is the main solvent
Dermal, instant application		
Product amount	50 mg /event	Based on different studies

a) The task is performed in a small, non-specified room of 20 m^3 with a low ventilation rate (0.6 h^{-1}).

Source: Modified from the *Paint Products Fact Sheet*, RIVM (2007b).

Table 11.9: Default Values for Spray Painting

	Default value	Comment
Spraying paint with a spray can		
Frequency	2 year^{-1}	Estimate
Inhalation, spray model		
Spray duration	15 min	Based on different studies
Exposure duration	20 min	It is assumed that the garage is left 5 minutes after spraying
Mass generation rate	0.33 g/sec	300 g of paint is sprayed in 15 minutes
Airborne fraction	1 g/g	See Table 11.2.1.1.
Weight fraction nonvolatile	0.3	Based on the composition of paint spray cans
Density non-volatile	1.5 g/cm^3	Based on the composition – see Table 11.2.1.2.
Initial droplet distribution – median (CV)	30 µm (0.8)	See "Cosmetics"
Inhalation cut-off diameter	15 µm	See "Cosmetics"
Dermal, constant rate		
Contact rate	100 mg/min	See "Cleaning products – aerosol spray cans"
Release duration	15 min	I.e. spray duration
Pneumatic spraying of paint		
Frequency	2 year^{-1}	Estimate
Inhalation, spray model		
Spray duration	800 sec	Spraying 400 g of paint (two radiators) with a mean mass generation rate of 0.5 g/sec lasts 800 sec (13.3 minutes).
Exposure duration	25 min	It is assumed that cleaning after spraying lasts circa 10 minutes and that the garage is left afterwards
Mass generation rate	0.5 g/sec	It is assumed that the mean mass generation rate is 50% higher than for a spray can, i.e. 0.5 g/sec.
Airborne fraction	0.2 g/g	See Table 11.2.1.1.
Weight fraction nonvolatile	0.5	Based on the composition
Density non-volatile	1.5 g/cm^3	See Table 11.2.1.2.
Initial droplet distribution – median (CV)	50 µm (0.6)	See "Cosmetics"
Inhalation cut-off diameter	15 µm	See "Cosmetics"
Dermal, constant rate		
Contact rate	110 mg/min	Default value for pneumatic spraying – surface spraying
Release duration	800 sec	I.e. spray duration

Both tasks are assumed to be performed in a garage which has a volume of 34 m^3, is 2.25 m high and has a ventilation rate of 1.5 h$^{-1.}$

Source: Modified from the *Paint Products Fact Sheet*, RIVM (2007b).

11.1.5 Disinfectant Products

Disinfectant products are used to control or to prevent growth of micro-organisms i.e. bacteria, viruses, and fungi. There is a great diversity in use and application types for the products. There are liquids, granulates, powders, tablets, gases. Some of these products can be used without any preparation, while others have to be processed (mixed and loaded) before use, for example by diluting or cutting up (RIVM, 2006d). In the *Disinfectant Products Fact Sheet*, RIVM (2006d), the "disinfectant products" are divided into the following product categories: algae, green deposit removers, swimming pool disinfectants, disinfectants for animal accommodations or animal transport vehicles (RIVM, 2006d). All models and parameters have been described earlier in the sections 11.2.1–11.2.4. Table 11.2.10 presents disinfectant products to be used by consumers. The standard room height is 2.5 m, the uptake fraction is 1 for oral, dermal and inhalation exposure and the room temperature is 20 °C. It is assumed that exposure takes place during light exercise; therefore, the inhalation rate is set at 24.1 litre/min.

Table 11.10: Default Values for Disinfectant Products

	Default Value	Comments
Algae removers: mixing and loading liquid		
Frequency	3 $year^{-1}$	It is assumed that the user treats the pavement in the spring, in the summer and before the winter.
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	Default value for mixing and loading of a liquid per operation. Based on different studies.
Exposure time	3 min	Default value for mixing and loading of a liquid. It is assumed that the exposure time (i.e. the contact time of the formulation with the skin) is longer than the application duration (1.33 min) and it is set at 3 minutes.
Algae removers: spraying		
Frequency	3 $year^{-1}$	See "Algae removers: mixing and loading liquid"
Inhalation, spray model		
Spray duration	16.7 min	The spray duration can be calculated by dividing the volume of diluted formulation by the mass generation rate i.e. 5000 ml divided by 300 ml/min resulting in 16.7 minutes, which is set as default value for both spray and exposure duration
Exposure duration	16.7 min	I.e. spray duration
Room volume	62.5 m^3	ConsExpo is developed for products applied indoors. As the spraying scenario describes application outdoors, the "spray" model will overestimate the inhalation exposure. For the scenario, a "room" volume is defined as 62.5 m^3, i.e. 25-m^2 surface area multiplied with 2.5 m (standard room) height. This is a worst-case situation!
Ventilation rate	0.6 hr^{-1}	Unspecified room
Mass generation rate	5.0 g/s	Estimate. Based on product information
Airborne fraction	0.2	See Table 11.2.1.1.
Weight fraction non-volatile	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance..
Density non-volatile	1.8 g/cm^3	Default value for complex mixture of (especially organic) compounds
Initial particle distribution Median (CV)	50 µm (0.6)	Default value (worst-case) for disinfectant trigger sprays
Inhalation cut-off diameter	15 µm	

	Default Value	Comments
Dermal, constant rate		
Contact rate	540 mg/min	The default value for contact rate is 32.35 g/hr (density 1 g/cm^3)
Release duration	16.7 min	I.e. spray duration
Algae removers: pouring and brushing		
Frequency	3 $year^{-1}$	See "Algae removers: mixing and loading liquid"
Dermal, instant application		
Exposed area	3300 cm^2	Area hands and arms
Product amount dilution	5 g	During brushing the pavement, droplets of the solution might settle on the skin. For estimating dermal exposure due to droplets, 0.05% of the diluted formulation is taken as default value for amount of spillage. An amount of 10 litres dilution is required for brushing a pavement surface area of 25 m^2; therefore, the dermal exposure is 0.05% of 10 000 ml i.e. 5 g diluted formulation (density 1 g/ cm^3).
Exposure time	25 min	The exposure time equals the application duration, which is estimated at 25 minutes i.e. one minute for pouring and brushing per square metre.
Mould removers: spraying		
Frequency	1 $year^{-1}$	It is assumed that after the winter the user treats the contaminated surface area i.e. once a year.
Inhalation, spray model		
Spray duration	11.1 min	Both registered black mould removers have a content of 500 ml). Both directions for use state that the content is enough for a surface area of 2 to 3 m^2. It is assumed that for 3 m^2 an amount of 500 ml (density 1 g/cm^3) is used. With a generation rate of 0.75 g/sec, a spray duration of 11.1 minutes is calculated.
Exposure duration	13 min	After spraying, the user leaves the bathroom
Room volume	10 m^3	Bathroom
Ventilation rate	2 hr^{-1}	Bathroom
Mass generation rate	0.75 g/s	The default value for the mass generation rate is given as 1.5 g formulation/sec. It is assumed that the total duration of the application is twice as long as the actual spraying duration; therefore, the default value for the average mass generation rate is set at 0.75 g/s.
Airborne fraction	0.2	See Table 11.2.1.1.
Weight fraction non-volatile	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance.
Density non-volatile	1.8 g/cm^3	See "Algae removers: spraying"
Initial particle distribution Median (CV)	50 µm (0.6)	See "Algae removers: spraying"
Inhalation cut-off diameter	15 µm	
Dermal, constant rate		
Contact rate	46 mg/ min	See "Algae removers: spraying"
Release duration	11.1 min	I.e. spray duration
Mould removers: rinsing		
Frequency	1 $year^{-1}$	See "Mould removers: spraying"
Dermal, instant application		
Exposed area	1900 cm^2	Skin surface area of forearms and hands
Product amount dilution	19 g	During rinsing the treated surface area, the user has dermal contact with the diluted formulation. The default value for the thickness of film layer on skin is 0.01 cm. With an exposed area of 1900 cm^2 the default value for (diluted) amount is 19 grams
Weight fraction dilution	W_f / 10	The amount of black mould remover on the surface is estimated at 85% of 500 g i.e. 425 g disinfectant product which is rinsed off. It is assumed that about 4.2 litres water is used to rinse the treated area; thus, the dilution is 10 times
Concentration, diffusion through skin	W_f / 10 g/cm^3	Density 1 g/cm^3
Exposure time	13 min	The default value for the cleaning duration is set at 4.35 min/m^2; this means that the exposure time for 3 m^2 is 13 minutes. Based on different studies.

	Default Value	Comments
Disinfectants for use indoors: spraying		
Frequency	365 $year^{-1}$	Estimate: 1 day^{-1}
Inhalation, spray model		
Spray duration	0.51 min	In the instructions for use of the disinfectant was stated that the surface must keep wet during the "leaving on" time. Therefore, the maximum amount is taken and to spray a kitchen working top of 1.71 m^2 requires an amount of 22.87 grams. Consequently, with a mass generation rate of 0.75 g/sec, the spray duration can be calculated as 0.51 minutes.
Exposure duration	60 min	The exposure duration is the sum of spraying time, time of leaving on, the cleaning time and the time staying in the specified room after application of the disinfectant products.
Room volume	15 m^3	Kitchen
Ventilation rate	2.5 hr^{-1}	Kitchen
Mass generation rate	0.75 g/s	The default value for the mass generation rate is given as 1.5 g formulation/sec. It is assumed that the total duration of the application is twice as long as the actual spraying duration; therefore, the default value for the average mass generation rate is set at 0.75 g/s.
Airborne fraction	0.2	See Table 11.2.1.1.
Weight fraction non-volatile	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance.
Density non-volatile	1.8 g/cm^3	See "Algae removers: spraying"
Initial particle distribution Median (CV)	50 µm (0.6)	See "Algae removers: spraying"
Inhalation cut-off diameter	15 µm	Default value
Dermal, constant rate		
Contact rate	46 mg/ min	See "Algae removers: spraying"
Release duration	0.51 min	I.e. spray duration
Surface disinfectants: wiping		
Frequency	365 $year^{-1}$	Estimate: 1 day^{-1}
Dermal, instant application		
Exposed area	215 cm^2	One palm; ¼ area hands
Product amount	0.02 g	The worst-case estimate is that 0.1% of the amount on the surface area (i.e. 19.4 g) contacts the skin
Exposure time	3 min	Estimate based on one study and the area of a kitchen work top (1.71 m^2)
Algae control liquids: mixing and loading liquid		
Frequency	28 $year^{-1}$	For the maintenance ration, the dosage is every 5 days for a period of 4 months. It is assumed that before, during and after the winter period i.e. during the off-season, a higher dose is applied (see use).
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	See "Algae removers: mixing and loading liquid"
Exposure time	3 min	See "Algae removers: mixing and loading liquid"
Application algae control liquid, swimming pool		
Frequency	28 $year^{-1}$	See "Algae control liquids: mixing and loading liquid"
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Product amount dilution	0.5 g	The contamination of emptying a 10 L container is 0.50 ml formulation per operation. In this case, the contamination is set at 0.5 g of diluted formulation (density 1 g/cm^3) during emptying the bucket
Weight fraction dilution	W_f / 10	The dilution is set at 10 times and so, the weight fraction should be divided by 10.
Concentration, diffusion through skin	W_f / 10 g/cm^3	Density 1 g/cm^3
Exposure time	5 min	Estimate

	Default Value	Comments
Dissolving granules: mixing and loading		
Frequency	122 $year^{-1}$	Once a day for a period of 4 months
Dermal, constant rate		
Contact rate	0.033 mg/min	The dermal exposure for consumers is estimated at 2 mg/hr
Release duration	1.33 min	It is assumed that the release duration has the same value as for application duration during mixing and loading liquids i.e. 1.33 minutes.
Application granules, swimming pool		
Frequency	122 $year^{-1}$	Once a day for a period of 4 months
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Product amount dilution	0.5 g	See "Application algae control liquid, swimming pool"
Weight fraction dilution	W_f / 20	Estimate
Concentration, diffusion through skin	W_f / 20	Density water 1 g/cm^3
Exposure time	5 min	Estimate
Dissolving tablets: mixing and loading		
Frequency	122 $year^{-1}$	Ten tablets of 20 g is used every days during 4 months
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	1 min	10 tablets. The release duration is the time during which the compound is applied. For loading tablets, the release duration is estimated at 6 seconds per tablet
Application tablets, swimming pool		
Frequency	122 year-1	Ten tablets of 20 g is used every days during 4 months
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Product amount dilution	0.5 g	See "Application algae control liquid, swimming pool"
Weight fraction dilution	W_f / 20	Estimate
Concentration, diffusion through skin	W_f / 20	Density water 1 g/cm^3
Exposure time	5 min	Estimate
Post-application swimming pool disinfectants; outdoor private swimming pool		
Frequency	52 $year^{-1}$	During a period of 4 months the user swims 3 times a week
Dermal, instant application		
Exposed area	17500 cm^2	The body
Product amount dilution	17500 g	It is assumed that not the total amount of swim water is in contact with the skin but only a layer of 1 cm around the exposed skin; thus, the amount of swim water is 17500 cm^3.
Exposure time	60 min	Estimate
Oral, constant rate		
Ingestion rate	830 mg/ min	The default value for ingestion rate is set at 50 ml/hr or 830 mg/min (density 1 g/cm^3). Based on different studies
Exposure time	60 min	Estimate
Waterbed conditioners: mixing and loading liquid		
Frequency	2 $year^{-1}$	Estimate
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	See "Algae removers: mixing and loading liquid"
Exposure time	3 min	See "Algae removers: mixing and loading liquid"
Disinfectants chemical toilets: mixing and loading liquid		
Frequency	7 $year^{-1}$	During a period of 28 days, the user empties the waste tank every 4 days
Inhalation, evaporation from a constant surface		
Exposure duration	1.33 min	Default value for mixing and loading liquid
Product amount	500 g	See "Algae removers: mixing and loading liquid"
Room volume	1 m^3	"Room volume" is interpreted here as "personal volume": a small area of 1 m^3 around the user.
Ventilation rate	0.6 hr^{-1}	Unspecified room
Release area	0.002 m^2	It is assumed that evaporation takes place from a bottle with a not-too-small circular opening with a 5-cm. diameter which gives a release areaof 20 cm^2
Application duration	1.33 min	See "exposure duration"
Density	1.0 g/ cm^3	Density water

	Default Value	Comments
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	See "Algae removers: mixing and loading liquid"
Exposure time	3 min	See "Algae removers: mixing and loading liquid"
Disinfectants rubbish bins: mixing and loading liquid		
Frequency	6 $year^{-1}$	It is assumed that the user disinfects the rubbish bin every month during springtime and summertime, which results in a frequency of 6 times a year
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	See "Algae removers: mixing and loading liquid"
Exposure time	3 min	See "Algae removers: mixing and loading liquid"
Disinfectants rubbish bins: application		
Frequency	6 $year^{-1}$	See "Disinfectants rubbish bins: mixing and loading liquid"
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Product amount dilution	5 g	For estimating the dermal exposure, a percentage of 0.1 is taken as default value for amount of spillage. An amount of 5 litres solution is required for disinfecting a dustbin; the dermal exposure is therefore 5 ml i.e. 5 g diluted formulation (density 1 g/ cm^3).
Exposure time	5 min	The exposure time is total duration for application, i.e. spreading the diluted formulation and draining off the excess of water, which is estimated at 5 minutes.
Disinfectants bird accommodations: fumigation		
Frequency	12 $year^{-1}$	The use frequency mentioned by pigeon fanciers on the internet were every fortnight, every month, twice a quarter, and every quarter. The frequency is set at once a month.
Inhalation, constant rate		
Exposure duration	0.5 min	It is assumed that the user leaves the dovecot directly after lightning the tablet. The default value for exposure duration for inhalation is set at 0.5 minute. At re-entry it is assumed that the air concentration of active substance is considerably diminished compared to the air concentration in the beginning of the disinfection.
Product amount	42.5 g	One package of 170 grams (one tablet) is sufficient for a room volume of 75 to 100 m^3 that is ¼ of tablet is sufficient for 17.5 – 25 m^3 (directions for use). Consequently, 42.5 grams of product will be applied for a dovecot of 20 m^3.
Room volume	20 m^3	The scenario describes a private user who sets fire to a quarter of a tablet (about 40 grams) containing paraformaldehyde in a dovecot of 20 m^3 measuring 4.30 m (length) x 2.50 m (height) x 1.85 m (depth).
Ventilation rate	0.6 hr^{-1}	Unspecified room
Emission duration	30 min	It is assumed that it takes 30 minutes to burn up the tablet with paraformaldehyde
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	0.5 min	The default value for the release duration for mixing and loading tablets is set at 0.1 minute. In this case, the user has to break and lighten the tablet; the release duration is estimated at 0.5 minute.
Disinfectants animal accommodations: mixing and loading powder		
Frequency	2 $year^{-1}$	Estimate
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	1.33 min	See "Dissolving granules: mixing and loading"

	Default Value	Comments
Disinfectants animal accommodations: mixing and loading tablets		
Frequency	2 $year^{-1}$	Estimate
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	0.5 min	The release duration is the time during which the compound is applied. According to different instructions for use, 4, 5 or 10 tablets in 10 litres should be used for disinfection animal accommodations; for tablets, the release duration is 0.1 minute per tablet. It is assumed that 5 tablets are dissolved in 5 litres of water and the release duration is set at 0.5 min.
Disinfectants animal accommodations: wiping		
Frequency	2 $year^{-1}$	Estimate
Dermal, instant application		
Exposed area	1900 cm^2	Area hands & forearms
Product amount dilution	19 g	See "Mould removers: rinsing"
Exposure time	20 min	The treated surface area is set at 20 m^2. The application "wiping" is more a question of spreading the diluted formulation to disinfect the surface than of cleaning. As default for wiping one minute per square meter is taken which results in an exposure duration of 20 min.
Disinfectants animal transports: mixing and loading powder		
Frequency	6 $year^{-1}$	Estimate
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	1.33 min	See "Dissolving granules: mixing and loading"
Disinfectants animal transports: mixing and loading tablets		
Frequency	6 $year^{-1}$	Estimate
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	1.0 min	The release duration is the time during which the compound is applied. According to the use instruction, 10 tablets in 10 litres should be used for disinfection animal accommodations. For tablets, the release duration is 0.1 minute per tablet. When dissolving 10 tablets in 10 litres water, the total release duration will be 1.0 minute.
Disinfectants animal transports: spraying		
Frequency	6 $year^{-1}$	Estimate
Inhalation, spray model		
Spray duration	17 min	The default value for exposure duration equals the duration for spraying which is set at 17 minutes i.e. 5 000 ml diluted formulation divided by 300 ml/min (5 g/sec)
Exposure duration	17 min	I.e. spray duration
Room volume	50 m^3	As the spraying scenario describes application outdoors, the "spray" model will overestimate the inhalation exposure. For the scenario, a "room" volume is defined as 50 m^3, i.e. 20-m^2 surface area (i.e. area around the trailer) multiplied with 2.5 m (standard room) height
Ventilation	0.6 hr^{-1}	Unspecified room
Mass generation rate	5 g/s	Default vale
Airborne fraction	0.2	See Table 11.2.1.1.
Weight fraction non-volatile	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance.
Density non-volatile	1.8 g/cm^3	See "Algae removers: spraying"
Initial particle distribution Median (CV)	50 µm (0.6)	See "Algae removers: spraying"
Inhalation cut-off diameter	15 µm	Default value
Dermal, constant rate		
Contact rate	540 mg/min	See "Algae removers: spraying"
Release duration	17 min	I.e. spray duration

	Default Value	Comments
Disinfectants milking machines: mixing and loading liquid		
Frequency	730 $year^{-1}$	The system cleaning of the automatic min-milking machine is done two times a day
Dermal, instant application		
Exposed area	215 cm^2	One palm: ¼ area hands
Product amount	0.01 g	See "Algae removers: mixing and loading liquid"
Exposure time	3 min	See "Algae removers: mixing and loading liquid"
Disinfectants milking machines: mixing and loading powder		
Frequency	730 $year^{-1}$	See "Disinfectants milking machines: mixing and loading liquid"
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	1.33 min	See "Dissolving granules: mixing and loading"
Disinfectants milking machines: mixing and loading tablets		
Frequency	730 $year^{-1}$	See "Disinfectants milking machines: mixing and loading liquid"
Dermal, constant rate		
Contact rate	0.033 mg/min	See "Dissolving granules: mixing and loading"
Release duration	0.1 min	The release duration is the time during which the compound is applied. According to the use instruction, one tablet in 10 (8) litres should be used for disinfection milking equipment. For tablets, the release duration is 0.1 minute per tablet
Disinfectants milking machines: disinfecting peripherals		
Frequency	730 $year^{-1}$	The system cleaning of the automatic min-milking machine is done two times a day
Dermal, instant application		
Exposed area	1900 cm^2	Area hands and forearms
Weight fraction dilution	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance.
Product dilution	19 g	Default value
Exposure time	5 min	Estimate
Post-application disinfectants drinking water: ingestion		
Frequency	14 $year^{-1}$	The scenario describes a private user who treats drinking water during a fortnight while staying on locations with bacteriological unreliable drinking water. The user drinks every day 2 litres of water
Oral, direct intake		
Amount ingested dilution	2000 g	See "frequency"
Weight fraction dilution	-	The weight fraction is the calculated weight fraction of the diluted formulation
Disinfectants water coolers: spraying		
Frequency	4 $year^{-1}$	Estimate; every three months
Inhalation, spray model		
Spray duration	0.9 min	With a mass generation rate of 0.36 g/s and an amount of 20 ml per application, the spray duration can be calculated as 0.9 min (density 1 g/cm^3).
Exposure duration	240 min	Estimate; four hours
Room volume	20 m^3	Unspecified room
Ventilation rate	0.6 hr^{-1}	Unspecified room
Mass generation rate	0.36 g/s	It is assumed that the mass generation rate of the disinfectant spray is much smaller compared to trigger sprays (1.5 g/sec) and twice as large compared to eau de toilette pump sprays. The default value for mass generation rate is set at 0.36 g/ sec.
Airborne fraction	0.2	See Table 11.2.1.1.
Weight fraction non-volatile	-	Calculated. In trigger sprays, the weight fraction of the non-volatile compounds is anyhow the weight fraction of the active substance.
Density non-volatile	1.8 g/ cm^3	See "Algae removers: spraying"
Inhalation cut-off diameter	15 µm	Default value

	Default Value	Comments
Dermal, constant rate		
Contact rate	46 mg/ min	See "Algae removers: spraying"
Release duration	0.9 min	I.e. spray duration
Post-application disinfectants water coolers: ingestion		
Frequency	4 $year^{-1}$	
Oral, direct intake		
Amount ingested dilution	1000 g	Estimate; one litre of water
Weight fraction dilution	-	The weight fraction is the calculated weight fraction of the diluted formulation

Source: Modified from the Disinfectant Products Fact Sheets, RIVM (2006d).

11.1.6 Children's toys

In the *Children's Toys Fact Sheet*, RIVM (2002), default values on different toys are classified according to the ways in which children can be exposed instead of by product type.

Default values on mouthing times for children are calculated based on an extensive study by Groot et al. (cited in RIVM, 2002). Results from the study are multiplied by a factor of 1.5 to include the night-time because only daily duration was considered in the study. For mouthing times on a pacifier, only average times are known and no standard deviations. The calculated default values on mouthing times for children are presented in Table 11.11.

With regard to the age category, RIVM has in each case chosen the age category for which the highest exposure is expected. In practice, it means that the youngest children who played with a certain type of toy were chosen for the defaults. The youngest children are the lightest and have the highest uptake per kg of body weight for the same exposure (RIVM, 2002). Moreover, when applying default values, it is not possible to work with time periods, but instead, a point in time must be chosen. For example, a body weight to a child of 3 to 6 months cannot be attributed; you must choose a point in time (4.5 months) (RIVM, 2002).

Table 11.11: Default Values on Mouthing Times for Children

Period[a] (months)	Age[a] (months)	Default mouthing times (min/day)			
		Pacifier	Toys for mouthing[b]	Other toys[c]	Non toys[d]
3–6	4.5	285	11	27	8
6–12	7.5	82	21	63	23
12–18	13.5	52	0	9	26
18–36	18	62	0	3	6

a) When applying default values, it is not possible to work with time periods. For example, you cannot attribute a body weight to a child of 3 to 6 months; you must choose a point in time (4.5 months).

b) Toys meant for mouthing: all kinds of teething rings, some rattles.

c) Other toys: cloth books, plastic books, cuddly toy.

d) Non toys: a piece of cloth, a piece of paper, a book for adults, flatware.

Reference: Modified from the *Children's Toys Fact Sheet*, RIVM (2002).

If a child puts an object in its mouth, pieces of the object can break away, and these can be swallowed. When toys are mouthed, pieces can also break off and be swallowed, such as paint from the metal toy car, for example. Apart from putting objects in the mouth, substances can be taken in by hand-mouth contact.

In order to estimate default values on direct ingestion, the following parameters must be taken in to account: the composition of the ingested product, the density of the product, the dilution of the product before it is ingested and the amount of product taken in. However, due to lack of measurements data on the amount ingested, only estimates on a few specific toys are made: modelling clay, paint from a toy car, and a ball pen. When calculating default values on mouth-hand contact the composition of the product ingested and the ingestion rate (in volume-units per unit time) are the only parameters that has to be estimated (RIVM, 2002). Table 11.12 presents default values on direct ingestion of children's toys and Table 11.13 presents default values on hand-mouth contact.

Table 11.12: Default Values on Direct Ingestion of Children's Toys

	Default value	Comments
Modelling clay[a)]		
Contact		
Frequency	52/year	Estimation
Total duration	60 min	Estimation
Use duration	60 min	Estimation
Oral		
Product volume	0.5 cm^3	Estimation
Density	2 g/cm^3	Estimation
Absorbed fraction	1	Potential dose
Paint from a toy car[b)]		
Contact		
Frequency	150/year	Estimation, 3x/week
Total duration	3 min	See Table 3.2.1. "other toys"
Use duration	3 min	See Table 3.2.1. "other toys"
Oral		
Product volume	0.05 cm^3	Estimation
Density	2 g/cm^3	Estimation
Absorbed fraction	1	Potential dose
Ball pen[c)]		
Contact		
Frequency	365/year	Estimation
Total duration	30 min	Estimation
Use duration	30 min	Estimation
Oral		
Product volume	0.2 cm^3	Estimation
Density	1.5 g/cm^3	Estimation
Absorbed fraction	1	Potential dose

a) For a 4.5 years old child weighting 16.3 kg – see section 3.2. and Table 3.2.1.

b) For an 18 months old child weighting 9.85 kg – see section 3.2. and Table 3.2.1.

c) For a 6.5 years old child weighting 20.6 kg – see section 3.2. and Table 3.2.1.

Source: Modified from the *Children's Toys Fact Sheet*, RIVM (2002).

Table 11.13: Default Values on Hand-Mouth Contact

	Default alue	Comments
Piece of chalk[a)]		
Contact		
Frequency	100/year	Estimate; 2 times per week
Total duration	45 min	Estimate
Use duration	45 min	Estimate
Oral		
Ingestion rate	6 mg/min	The estimate of the ingestion rate for the piece of chalk is based on soil, i.e. on the default of 300 mg per day (thus an ingestion of 300 mg in 50 minutes). The daily intake is calculated to be 45/50 x 300 =270 mg. This amount is ingested in 45 minutes; the ingestion rate is therefore 6 mg/min.
Absorbed fraction	1	Potential dose
Finger paint[b)]		
Contact		
Frequency	100/year	Estimate; 2 times per week
Total duration	45 min	Estimate
Use duration	45 min	Estimate
Oral		
Ingestion rate	30 mg/min	Based on the differences between soil and mud, the default value for products which stick to the skin is first estimated at an amount 5 times as large (as soil/chalk), i.e. the ingestion rate for finger paint is estimated at 30 mg/min.
Absorbed fraction	1	Potential dose
Face paint[a)]		
Contact		
Frequency	12/year	Estimate
Total duration	480 min	Estimate
Use duration	480 min	Estimate
Oral		
Ingestion rate	0.44 mg/min	For the indirect contact with face paint, it should be noted that it concerns a substance that sticks to the skin and, in addition to dermal exposure, is taken in orally via the hands. It is assumed that the face paint is removed at the end of the day (default: after 8 hours; 480 min.). The total amount of face paint on the skin is 1.4 g (see: § 5.4.2). We estimate that 15% of this is ingested per day, which means an ingestion rate of 210/480 = 0.44 mg/min.
Absorbed fraction	1	Potential dose

a) For a 4.5 years old child weighting 16.3 kg – see section 3.2. and Table 3.2.1.

b) For an 18 months old child weighting 9.85 kg – see section 3.2. and Table 3.2.1.

Source: Modified from the Children's Toys Fact Sheet, RIVM (2002).

With regard to inhalation, the *Children's Toys Fact Sheet*, RIVM (2002) refers to the more or less volatile organic compounds that evaporate from the toy. The inhalatory exposure to fine particles is described with the "cloud volume" model in section 11.2. This model is developed to estimate exposure to aerosols, but exposure to particles falls within the assumptions of the model. The user of the product that produces particles is assumed, worst case, to have his "nose in the cloud". Default values on inhalation from children's toys are presented in Table 11.14.

Table 11.14: Default Values on Inhalation from Children's Toys

	Default value	Comments
Dust from chalk[a)]		
Contact		
Frequency	100/year	See Table 12.2.2.3.
Total duration	45 min	
Use duration	45 min	
Inhalation		
Emission rate formulation	11 mg/min	It is assumed that 10 gram of chalk is used. It is estimated that 5% of the used chalk is released as dust in the air, resulting in 500 mg. If this is released over 45 minutes, the average emission rate becomes 11 mg/minute.
Density	2 g/cm^3	Estimation
Airborne fraction	0.05 g/g	The airborne fraction defines how much of the potential release of particles is actually released into air. No data is available for the particle size distribution of chalk dust. It is assumed that the smallest 10% of the dust particles have an average size of 25 µm, and that 5% has an average size of 10 µm. The default for the airborne fraction is set to 0.05, the default for the particle size to 10 µm and the default for the respirable fraction to 1.7%. These defaults imply that less than 0.1% (0.05 x 0.017 = 0.00085) of the chalk dust is available for inhalatory exposure.
Droplet size	10 µm	
Release height	100 cm	Estimation
Radius aerosol cloud	20 cm^3	Estimation
Room volume	20 m^3	
Target area	8 m^2	Surface room
Absorbed fraction	1	Potential dose
Inhalation rate	9.2 l/min	
Respirable fraction	1.7%	See airborne fraction and droplet size
Dust from blusher[a)]		
Contact		
Frequency	12/year	Estimation
Total duration	480 min	8 hours; estimation
Use duration	5 min	Estimation
Inhalation		
Emission rate formulation	12 mg/min	It is estimated that 300 mg of blusher is used in 5 minutes time. It is assumed that 20% of this amount is released into air, being 60 mg. The emission rate of dust is therefore 12 mg/minute.
Density formulation	1.8 g/cm^3	Estimation
Airborne fraction	0.05 g/g	See emission rate formulation
Droplet size	10 µm	See dust of chalk
Release height	100 cm	Estimation
Radius aerosol cloud	20 cm	Estimation
Room volume	20 m^3	
Target area	8 m^2	Surface room
Absorbed fraction	1	Potential dose
Inhalation rate	9.2 l/min	
Respirable fraction	1.7%	See dust of chalk

a) For a 4.5 years old child weighting 16.3 kg – see section 3.2. and Table 3.2.1.

Source: Modified from the Children's Toys Fact Sheet, RIVM (2002).

Children use cosmetics as a game to imitate the behaviour of adults and are therefore exposed to cosmetic products on the skin. The use of cosmetics during play will often take place during dressing up, at children's parties, for example. It will therefore usually occur incidentally and not periodically, as is usual with cosmetics. The sorts of cosmetics usually used are those with which a colour is applied i.e. lipsticks, nail polish, eye shadow and blusher. It is assumed that if cosmetics are used during

play, these 4 products will be applied one after the other. According to RIVM, it is assumed that the amount that is applied is 3 times as large (unit per surface) as the amount of cosmetics that is usually used (RIVM, 2002). Default values for cosmetics used as children's toy, is presented in Table 11.15. Face paint is described in Table 11.3.

Table 11.15: Default Values for Cosmetics as Children's Toys – Application on Skin

	Default value	Comments
Lipstick[a)]		
Contact		
Frequency	12x/ year	Estimation
Use duration	3 min	Estimation
Total duration	240 min	4 hours; estimation
Oral		
Amount product	0.03 g	Estimation based on the use of cosmetics by adults – see Table 11.2.1.1.
Density	1.3 g/cm^3	Estimation
Absorbed fraction	1	Potential dose
Nail polish[a)]		
Contact		
Frequency	12x/ year	Estimation
Use duration	5 min	Estimation
Total duration	480 min	8 hours; estimation
Dermal		
Amount product	0.75 g total, 0.25 g on skin	1/3 on skin, 2/3 on nail, estimation
Density	0.9 g/cm^3	Estimation
Exposed area	10 cm^2	On skin, estimation
Blood volume	1 cm^3	
Skin blood flow	0.14 cm^3/min	
Eye shadow[a)]		
Contact		
Frequency	12x/ year	Estimation
Use duration	5 min	Estimation
Total duration	480 min	8 hours; estimation
Dermal		
Amount product	0.03 g	Estimation based on the use of cosmetics by adults – see Table 11.2.1.1.
Density	1.3 g/cm^3	Estimation
Exposed area	8 cm^2	Estimation
Blood volume	0.8 cm^3	
Skin blood flow	0.11 cm^3/min	
Blusher[a)]		
Contact		
Frequency	12x/ year	Estimation
Use duration	5 min	Estimation
Total duration	480 min	8 hours; estimation
Dermal		
Amount product	0.3 g total	3 mg/cm^2
Density	1.8 g/cm^3	Estimation
Exposed area	100 cm^2	Estimation
Blood volume	10 cm^3	
Skin blood flow	1.4 cm^3/min	

a) For a 4.5 years old child weighting 16.3 kg – see section 3.2. and Table 3.2.1.

Source: Modified from the *Children's Toys Fact Sheet*, RIVM (2002).

Children are exposed to intensive hand contact via playing with finger paint and modelling clay. In the *Children's Toys Fact Sheet*, RIVM (2002), it assumed that the product is continuously present on the hands. Since there is intensive hand contact for a prolonged period of time, the total amount of clay is taken as the amount of product. The crucial difference is the age of the users: finger paint will be used by much younger chil-

dren than for modelling clay. Table 11.16 presents default values on intensive hand contact during play.

Table 11.16: Default Values on Intensive Hand Contact during Play

	Default value	Comments
Modelling clay[a)]		
Contact		
Frequency	52 x/ year	Estimation
Use duration	60 min	Estimation
Total duration	60 min	Estimation
Dermal		
Amount product	350 g	Estimation
Density	2 g/cm^3	Estimation
Exposed area	390 cm^2	Area hands
Blood volume	39 cm^3	
Skin blood flow	5.5 cm^3/min	
Finger paint[b)]		
Contact		
Frequency	100 x/ year	Estimation
Use duration	45 min	Estimation
Total duration	45 min	Estimation
Dermal		
Amount product	20 g	Estimation
Density	1.3 g/cm^3	Estimation
Exposed area	124 cm^2	½ area hands
Blood volume	12 cm^3	
Skin blood flow	1.7 cm^3/min	

a) For a 4.5 years old child weighting 16.3 kg – see section 3.2. and Table 3.2.1.

b) For an 18 months old child weighting 9.85 kg – see section 3.2. and Table 3.2.1.

Source: Modified from the Children's Toys Fact Sheet, RIVM (2002).

11.2 US-EPA

In the *Exposure Factors Handbook* (US-EPA, 2009), information on the amount of product used, frequency of use, and duration of use for various consumer products typically found in consumer households, is provided. However, due to the large range and variation among consumer products and their exposure pathways, no recommendations on specific exposure values are given.

No data on consumer product from the US will be included in this report. This is because this report is directed primarily towards the exposure factors to be used in exposure assessments in EU in the context of REACH and therefore, the focus will be on the numerous and well validated European data.

11.3 WHO

No recommendations on consumer products are provided by WHO.

11.4 Conclusion and Recommendations

RIVM has provided Fact Sheets with default values on several consumer products which are calculated using the ConsExpo software model. The default values in the fact sheets have been collected for consumers (private or non-professional users). They are not aimed at describing exposure for people who professionally work with consumer products, such as hairdressers and in hospitals, for example. These fact sheets, therefore, only describes consumer products which are available to the consumer for private use.

In the fact sheets provided by the RIVM, the basis for the calculation and/or estimation of the default parameter values is a realistic worst-case scenario, and considers consumers who frequently use a certain product under relatively less favourable circumstances. For example, when using a cosmetic product, basic assumptions are: relatively frequent use, application of a relatively large amount in a small room with a low ventilation rate, and a relatively long stay in that room. The parameter values in the fact sheets are aimed at (Dutch) consumers. They are chosen such that a relatively high exposure and uptake are calculated, in the order of magnitude of a 99th percentile of the distribution. To achieve this goal, the 75th or the 25th percentile is calculated (or estimated) for each parameter. The 75th percentile is used for parameters which give a higher exposure for higher values, and the 25th percentile is used in the reverse case (RIVM, 2006a).

Therefore, circumstances are chosen in such a way that it will lead to relatively high exposure. In order to assess the exposed area, RIVM uses the default value for surface areas from the *General Fact Sheets*, RIVM (2006a) (see section 3.1) and the *Exposure Factors Handbook*, US-EPA, (1997) (see section 3.2).

No data on consumer product from the US has been included in this report as the primary focus is on the exposure factors to be used in the context of REACH and there are numerous European data.

No recommendations on consumer products are provided by WHO.

In conclusion, the European recommendations are considered as being valid values for consumer products and are therefore, recommended as the default exposure factors for assessments of the European population in the context of REACH.

12. Summary, Conclusions and Recommendations

The aim of an exposure assessment is to determine the nature and extent of contact with chemical substances experienced or anticipated under different conditions. An exposure assessment is the quantitative or qualitative evaluation of the amount of a substance that humans come into contact with and includes consideration of the intensity, frequency and duration of contact, the route of exposure (e.g., dermal, oral or respiratory), rates (chemical intake or uptake rates), the resulting amount that actually crosses the boundary (a dose), and the amount absorbed (internal dose).

In order to perform an exposure assessment, it is necessary to apply various "non-chemical-specific" exposure related parameters such as e.g., body weight, body surface area, activity factors, ventilation rates, ingestion of water/food etc. These parameters are called non-chemical-specific exposure factors and are generally drawn from the scientific literature or governmental statistics.

The approach to exposure assessment is not as internationally harmonised as hazard assessment. Although broad consistency in the overall approaches used by different bodies and countries in conducting exposure assessment exists, there is variation in the types of approaches and tools used, including the use of exposure factors.

The purpose of this report is to give an overview of non-chemical-specific exposure factors to be used by the authorities during the process of assessing exposure to both adults and children as well as of risk assessments in the context of the EU chemical regulation "REACH", and to contribute towards a further harmonisation of such exposure factors to be used in exposure assessments. Thus, the process of exposure assessment in itself is not further addressed in this report.

Guidance and recommendations provided by various EU bodies, with the main focus on the information gathered in the REACH "*Guidance on Information Requirements and Chemical Safety Assessment*" (REACH TGD) published by the European Chemicals Agency (ECHA) (ECHA, 2010), have primarily been addressed as this report is directed primarily towards the exposure factors to be used in exposure assessments in the context of the EU chemical regulation "REACH". The US guidance and recommendations are also addressed as the most recent version of the US-EPA *Exposure Factor Handbook*, *currently (October 2010) available in the form of an external review draft (US-EPA, 2009)* provides the most comprehensive overview, considerations, evaluations and recommenda-

tions in the area of non-chemical-specific exposure factors. In addition, guidance and recommendations provided by the WHO are addressed as this report also is meant to contribute towards a further harmonisation of exposure factors to be used in exposure assessments.

The following non-chemical-specific exposure factors are addressed in this report:

- Body weight
- Body surface areas
- Inhalation rates
- Ingestion of drinking water
- Intake of food
- Ingestion of soil and dust
- Non-dietary ingestion factors
- Lifetime expectancy
- Activity factors
- Consumer products

In general, the data presented in the US-EPA Exposure Factors Handbook (EFH) (US-EPA, 2009) are the most comprehensive, whereas the European data are more limited as are the WHO data. The US guidance and recommendations will be addressed using a recent US-EPA *Exposure Factor Handbook*, *(December 2010) available in the form of an external review draft (US-EPA, 2009), which* provides the most comprehensive overview and data basis, considerations, evaluations and recommendations in the area of non-chemical-specific exposure factors. The revised *Exposure Factor Handbook* was published in September 2011, after the finalisation of the work in this Nordic report.

The US-EPA recommended values are very well validated. The US-EPA has assigned a confidence rating of low, medium, or high to each recommended value (US-EPA, 2009). The US-EPA has underscored that this qualitative rating was not intended to represent uncertainty analyses but to represent the US-EPA's judgment on the quality of the underlying data used to derive the recommendations. The judgment was made using five so-called "general assessment factors" (GAFs, described in Section 1.2). The US-EPA noted that there is a continuum from low to high, and that judgment was used to assign a rating to each factor. The recommended values presented in the EFH (US-EPA, 2009) are accompanied by a discussion of the rationale for their rating.

The US-EPA recommendations (US-EPA, 2009) have formed the basis for the recommended values in this report for many of the human exposure factors. One reason is that the US-EPA recommended values generally are based on the most comprehensive and well validated data, whereas the European data are more scarce and limited. Furthermore, the US-EPA recommended values are considered as being the most valid values for most of the human exposure factors as these values in general

are based on analyses of more recent data than the European data, which in general are based on older references (published more than 10 years ago). In addition, the US-EPA recommended values in general are considered as being representative for Europeans as well for many of the human exposure factors despite that Americans might be different to Europeans in some ways. Finally, harmonisation of default values for exposure factors to be used in exposure assessments would be desirable, i.e., the ideal situation. As this report is also meant to contribute towards a further harmonisation of human exposure factors to be used in exposure assessments, the most comprehensive and well validated data in most cases have been selected as the basis for the recommended values for each exposure factor in this report regardless whether the data are European or American.

In the following sections, the recommended values for the non-chemical-specific exposure factors addressed in this report are presented. Although the focus of this report is to recommend values for non-chemical-specific exposure factors to be used in the context of the EU chemicals regulation "REACH", the recommended values can also be used in the context of other chemical regulations such as those for e.g., biocides, pesticides, cosmetics, toys etc. The percentiles chosen is a decision that has to be made by the assessor depending on the purpose of the assessment. For transparency, the reasoning for the choice of values should always be available in the assessment.

12.1 Body weight

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are more limited as are the WHO data.

Americans tend, in average to weigh more than Europeans. Despite this, the US-EPA recommended values for children body weights are considered as being representative for European children as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for body weights as today as these recommendations are based on analyses of the most recent data (NHANES 1999–2006), whereas the European data are predominantly based on older references (ICRP, 1975; US-EPA, 1997; UK Statistics from 1999), or no references have been provided for the recommended values (e.g., REACH TGD Chapter R15). For adults, the currently most used value for average body weight of 70 kg for men and women combined is probably more representative for Europeans than the average US adult body weight of 80 kg. However, also in Europe, the adult body weight is increasing and therefore, probably approaching the American body weights of today.

In conclusion, the US-EPA recommended values presented in Table 2.4 are considered as being the most valid values for body weight as today and are therefore recommended as default exposure factors for assess-

ments of European children in the context of REACH. For adults, however, the currently most used value for average body weight of 70 kg for men and women combined is still recommended as the default value for exposure assessments of the European population in the context of REACH. In addition to the average body weight for men and women combined, a default value of 70 kg for men and of 60 kg for women is recommended.

12.2 Body Surface Area

The data presented in the US-EPA EFH (US-EPA, 2009) as well as the European data are comprehensive. No recommendations have been provided by the WHO.

Americans tend, in average, to weigh more and thus to have a greater body surface area than Europeans. Despite this, the US-EPA recommended values for body surface areas are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for body surface areas as today as these recommendations are based on analyses of the most recent data (NHANES 1999–2006), whereas the European data are predominantly based on older data, primarily the 1997 version of the EFH (US-EPA, 1997). However, also in Europe, the adult body weight is increasing and thus, also the body surface area and therefore, probably approaching the American body weights and body surface area of today.

In conclusion, the US-EPA recommended values presented in Table 3.2 and 3.3 are considered as being the most valid values for body surface areas as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

12.3 Inhalation rates

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited as are the WHO data.

Activity levels might be different among US individuals compared to Europeans. Despite this, the US-EPA recommended values for inhalation rates are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for inhalation rates as today as these recommendations are based on four recent key studies published in the period from 2006–2009. In addition, the US-EPA has noted that these key studies represent an improvement upon those previously used for recommended inhalation rates in previous versions of the EFH. In contrast, the European data are predominantly based on older references (ICRP, 1975; AUH 1995, US-EPA, 1997) or no references have been provided for the recommended values (e.g., REACH TGD Chapter R8, Table R. 8–2). One

European body, namely EFSA (EFSA; 2010) has based their recommended values on the most recent version of the EFH (US-EPA, 2009). It should also be noted that ECETOC has considered that the American values are probably representative of Europeans as well.

In conclusion, the US-EPA recommended values presented in Table 4.5 and 4.6 are considered as being the most valid values for inhalation rates as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

12.4 Drinking water

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited as are the WHO data.

The intake of bottled beverages may be more common today than it was thirty years ago. Therefore, the more recent recommendations from the US-EPA (US-EPA, 2009) may be more representative of the intake of tap water as today compared to the recommended values from ECETOC, which have been based upon a thirty-year old survey as it has been described in the 1997 version of the EFH (US-EPA, 1997). However, it is possible that the US population consumes more bottled beverages than the European population and that the US data therefore underestimate the actual intake of tap water consumed by the European population. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommended values are considered as being the most valid values for intake of drinking water as today as these recommendations are based on two very recent key studies published in 2008. In contrast, the European data are predominantly based on older references (ICRP, 1975; US-EPA, 1997).

In conclusion, the US-EPA recommended values presented in Table 5.2 are considered as being the most valid values for intake of drinking water as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

12.5 Food Intake

The data presented in the US-EPA EFH (US-EPA, 2009) as well as the European data are comprehensive, whereas the WHO data are limited.

The Danish data on dietary habits (DTU-FOOD, 2010) are considered as being the most valid values for food consumption rates as these recommendations are based on analyses of the most recent data and are considered to be representative for Europeans in general.

There might be some differences between US and European infants regarding breast milk intake. However, according to ECETOC (ECETOC, 2001), breast milk consumption values for Swedish infants were similar

to those of US infants. Thus, the more recent US-EPA recommendations (US-EPA, 2009) are considered as being representative for European infants as well.

In conclusion, the Danish data on dietary habits presented in Table 6.1 are considered as being the most valid values for food consumption rates today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH. For breast milk intake, the US-EPA recommendations presented in Table 6.9 are considered as being the most valid values as today and are therefore recommended as default exposure factors for assessments of European infants in the context of REACH.

12.6 Soil and Dust Ingestion

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. There are some European data, but the WHO data are limited.

Data on soil and dust ingestion rates are generally limited and variable, and region specific differences in child play and hygienic patterns will likely affect typical soil and dust ingestion rates. Thus, there might be some differences between the US and European population regarding soil and dust ingestion. Even though the US-EPA recommendations are considered as being the most valid values for soil and dust ingestion rates, the recommended values for house dust ingestion for adults and children proposed from RIVM (RIVM, 2008) are considered as being representative for the European population. For children's dust ingestion the ECHA *Guidance on information requirements and chemical assessment. Chapter R. 15: Consumer exposure estimation* (ECHA. 2008b) also refers to the Dutch data.

In conclusion, the ECHA recommended values presented in Table 7.1 are considered as being the most valid values for soil and dust ingestion ratesin Europe as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

12.7 Non-Dietary Ingestion Factors

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited to single values for specific assessment purposes. No recommendations have been provided by the WHO.

There might be some differences between US and European children regarding hand-to-mouth and hand-to-object frequency and duration. Despite this, the US-EPA recommended values are considered as being representative for European children as well. Furthermore, the US-EPA

recommendations are considered as being the most valid values for non-dietary ingestion factors as today despite the overall rating as low, as these recommendations are based on relatively recent key studies published in the period 2001–2008.

In conclusion, the US-EPA recommended values presented in Table 8.1 are considered as being the most valid values for non-dietary ingestion factors as today and are therefore recommended as default exposure factors for assessments of European children in the context of REACH. No studies have been located on mouthing frequency or duration for adults and therefore, no default exposure factors can be recommended.

12.8 Lifetime Expectance

Life expectancy is very different for various countries in the world. The very recent data published by the WHO in 2010 are considered as being the most representative for European lifetime expectancy as today.

In conclusion, the WHO recommended values for the European region presented in Table 9.2 are considered as being the most valid values for lifetime expectancy as today and are therefore recommended as default exposure factors for assessments of the European population in the context of REACH.

12.9 Activity Factors

The data presented in the US-EPA EFH (US-EPA, 2009) are the most comprehensive. The European data are limited. No recommendations have been provided by the WHO.

Activity levels might be different among US individuals compared to Europeans. Despite this, the US-EPA recommended values are considered as being representative for Europeans as well. Furthermore, the US-EPA recommendations are considered as being the most valid values for activity factors. It should be noted that the recommended values in the 2009 version of the EFH (US-EPA, 2009) are based on two key studies published in 1991 and 1996 and the ECETOC recommendations are based on different sources published in the 1990'ies.

In conclusion, the US-EPA recommended values presented in Table 10.2 are considered as being the most valid values for activity factors for Europeans as today and are therefore recommended as default exposure factors for assessments of European inhabitants in the context of REACH. No default values for working activities are recommended by the US-EPA as the working environment is not the responsibility of US-EPA. For working activities, the recommended values presented in Table 10.1 are recommended as default exposure factors for assessments of European workers in the context of REACH.

12.10 Consumer Products

RIVM has provided Fact Sheets with default values on several consumer products which are calculated using the ConsExpo software model. The default values in the fact sheets have been collected for Dutch consumers (non-professional users). They are not aimed at describing exposure for people who professionally work with consumer products, such as hairdressers and in hospitals, for example. These fact sheets, therefore, only describes consumer products which are available to the consumer for private use. The parameter values in the fact sheets are chosen such that a relatively high exposure and uptake are calculated, in the order of magnitude of a 99th percentile of the distribution. To achieve this goal, the 75th or the 25th percentile is calculated (or estimated) for each parameter. The 75th percentile is used for parameters which give a higher exposure for higher values, and the 25th percentile is used in the reverse case (RIVM, 2006a). In order to assess the exposed area, RIVM uses the default value for surface areas from the General Fact Sheets (RIVM, 2006a) (see Section 3.1) and the Exposure Factors Handbook (US-EPA, 1997) (see Section 3.2).

No data on consumer product from the US has been included in this report as the primary focus is on the exposure factors to be used in the context of REACH and there are numerous European data.

In conclusion, the European recommendations are considered as being valid values for consumer products and are therefore, recommended as the default exposure factors for assessments of the European population in the context of REACH.

13. Annex A.

Body Weight – Supplementary Tables

Table A.1. Estimated Mean Adult (> 20 Years Old) Body Weight for Year 2000 – European Countries

Region and Country	Men	Women	Men and Women Combined
		Mean (kg)	
Eastern Europe			
Belarus	75.77	69.27	72.52
Bulgaria	61.07	53.93	57.50
Czech	75.28	65.29	70.29
Rep. Hungary	79.39	68.89	74.14
Poland	75.15	60.18	67.67
Moldova	75.77	69.27	72.52
Romania	61.07	53.93	57.50
Russia	75.77	69.27	72.52
Slovakia	75.28	65.29	70.29
Ukraine	75.77	69.27	72.52
E. Eur. Average	*74.22*	*66.48*	*70.35*
Northern Europe			
Denmark	83.61	68.46	76.03
Estonia	75.77	69.27	72.52
Finland	83.61	68.46	76.03
Iceland	78.92	69.07	73.99
Ireland	77.24	67.58	72.41
Latvia	75.77	69.27	72.52
Lithuania	75.77	69.27	72.52
Norway	78.92	69.07	73.99
Sweden	83.61	68.46	76.03
United Kingdom	77.24	67.58	72.41
N. Eur. Average	*78.56*	*67.97*	*73.27*
Southern Europe			
Albania	61.07	53.93	57.50
Bosnia-Herzegovin	61.07	53.93	57.50
Croatia	61.07	53.93	57.50
Greece	76.13	66.94	71.54
Italy	73.23	62.56	67.89
Macedonia FYR	61.07	53.93	57.50
Malta	61.07	53.93	57.50
Portugal	61.07	53.93	57.50
Slovenia	61.07	53.93	57.50
Spain	73.23	62.56	67.89
Yugoslavia	75.28	60.44	67.86
S. Eur. Average	*71.54*	*61.28*	*66.41*
Western Europe			
Austria	79.39	68.89	74.14
Belgium	79.78	66.38	73.08
France	77.73	66.78	72.26
Germany	84.51	71.63	78.07
Luxemburg	77.73	66.78	72.26
Netherlands	87.80	74.37	81.08
Switzerland	79.42	67.60	73.51
W. Eur. Average	*81.97*	*67.60*	*73.51*
Europe Average	*76.46*	*76.46*	*71.51*

Source: WHO Global database on Body Mass Index WHO, 1999a; modified from ECETOC, 2001

Table A.2. Mean and Body Weight from the key study

Age Group	Men		Women	
	Mean (kg)	95th (kg)	Mean (kg)	95th (kg)
0–1 month	4.9	6.8	4.6	5.9
1–<3 months	6.0	7.3	5.7	7.3
3–<6 months	7.6	9.1	7.2	9.0
6–<12 months	9.4	11.5	9.0	11.2
1–<2 years	11.6	14.3	11.1	13.7
2–<3 years	14.1	17.0	13.5	17.1
3–<6 years	18.8	26.2	18.3	26.2
6–<11 years	31.9	51.4	31.7	53.4
11–<16 years	57.6	91.8	55.9	86.3
16–<21 years	77.3	113.0	65.9	99.7
21–<30 years	84.9	123.0	71.9	109.0
30–<40 years	87.0	124.0	74.8	113.0
40–<50 years	90.5	125.0	77.1	118.0
50–<60 years	89.5	123.0	77.5	117.0
60–<70 years	89.1	120.0	76.8	112.0
70–<80 years	83.9	113.0	70.8	98.2
≥80 years	76.1	100.0	64.1	89.1

Source: US-EPA analysis of NHANES, 1999–2006 data, modified from US-EPA, 2009.

Table A.3. A Recent Relevant Body Weight Study Representative for the US Population

Age Group	Mean (kg)	95th Percentile
0–1 month	4	5
1–<3 months	5	7
3–<6 months	7	10
6–<12 months	9	12
1–<2 years	12	15
2–<3 years	14	19
3–<6 years	18	25
6–<11 years	30	45
11–<16 years	54	82
16–<18 years	67	100
18–<21 years	69	100
21+	76	107
65+	72	100

Source: Kahn and Stralka, 2008, modified from US-EPA, 2009.

Table A.4. Neonatal Weight by Gestational Age for Men and Women Combined

Gestational Age (weeks)	Weight (g)	
	50th Percentile	95th Percentile
25	660	968
26	760	1,103
27	875	1,257
28	1,005	1,430
29	1,153	1,623
30	1,319	1,836
31	1,502	2,070
32	1,702	2,321
33	1,918	2,587
34	2,146	2,865
35	2,383	3,148
36	2,622	3,428
37	2,859	3,698
38	3,083	3,947
39	3,288	4,164
40	3,462	4,340
41	3,597	4,462
42	3,685	4,523
43	3,717	4,515

Source: Doubilet et al., 1997, modified from US-EPA, 2009.

14. Annex B.

Body Surface Area – Supplementary Tables

Table B.1. Default Values for Body Weight and Surface Area of Adults in 25th Percentiles – as presented by RIVM

	Men		Women		Men and Women Combined	
Weight (kg)	*74*		*61*		*64*	
Surface Area	**m^2**	**Percent**	**m^2**	**Percent**	**m^2**	**Percent**
Head	0.116	6.6	0.122	6.4	0.113	6.7
Trunk	0.630	36	0.695	36.4	0.585	34.8
Arms	0.245	14	0.273	14.3	0.232	13.8
Hands	0.086	4.9	0.094	4.9	0.082	4.9
Legs	0.560	32	0.602	31.5	0.553	32.9
Feet	0.117	6.7	0.124	6.5	0.116	6.9
Total	1.75	100	1.91	100	1.68	100

Source: Modified from RIVM, 2006a

Table B.2. Default values of body weight and body surface of children – as Presented by RIVM

Age	Body Weight (kg)	Body Surface (m^2)	Body Surface in Percent			
			Head	Trunk	Arms+Hands	Legs+Feet
1.5 months	4.30	0.270	20.4	32.2	16.9	30.5
4.5 months	6.21	0.346	19.5	32.8	17.2	30.5
7.5 months	7.62	0.398	18.5	33.5	17.4	30.6
10.5 months	8.69	0.437	17.6	34.1	17.7	30.6
13.5 months	9.47	0.467	16.9	34.3	17.9	30.9
1.5 year	9.85	0.480	16.2	34.0	18.15	31.65
2.5 years	12.5	0.575	14.8	33.6	18.65	32.95
3.5 years	14.1	0.640	14.05	33.35	19.1	33.5
4.5 years	16.3	0.709	13.4	33.05	19.5	34.05
6.5 years	20.6	0.841	12.5	33.45	19.45	34.55
9.5 years	28.4	1.05	11.2	33.55	19.3	35.95
12.5 years	39.3	1.31	9.8	33.15	19.6	37.4
13.5 years	43.9	1.40	9.4	32.75	20.0	37.8
16.5 years	56.8	1.65	8.3	31.65	21.35	38.65
17.5 years	58.2	1.67	8.05	32.1	21.0	38.8

Source: Modified from RIVM, 2006a.

Table B.3. Default values of body weight and body surface of children – as Presented by RIVM

Age	Body Weight (kg)	Body Surface (m^2)	Body surface in Percent					
			Head	Trunk	Arms	Hands	Legs	Feet
4.5 months	6.21	0.346	19.5	32.8	12.1	5.1	23.5	7.0
7.5 months	7.62	0.398	18.5	33.5	12.2	5.2	23.6	7.0
13.5 months	9.47	0.467	16.9	34.3	12.6	5.3	23.8	7.1
1.5 year	9.85	0.480	16.2	34.0	13.0	5.15	25.05	6.6
4.5 years	16.3	0.709	13.4	33.05	14.0	5.5	26.95	7.1
6.5 years	20.6	0.841	12.5	33.45	13.95	5.5	27.35	7.2
12.5 years	39.3	1.310	9.8	33.15	13.9	5.7	30.0	7.4

Source: Modified from RIVM, 2006a.

Table B.4. Skin Surface Area Distributions based upon Lognormal Body Weight Distributions

Age group and Surface Area Equation	Mean (m^2)	95th Percentile (m^2)
Men		
Costeff	1.91	2.19
Burmaster	2.08	2.51
Women, 2 years		
Costeff	0.59	0.70
Burmaster	0.60	0.70
Men, 2 years		
Costeff	0.62	0.72
Burmaster	0.64	0.74
Women, 10 years		
Costeff	1.20	1.51
Burmaster	1.17	1.49
Men, 10 years		
Costeff	1.19	1.45
Burmaster	1.12	1.48

Source: Health Survey for England (HSE) Data (1996 for Adult Males, 1995–1997 for Children), modified from ECETOC, 2001.

Table B.5. Percentage of Total Surface Area that is Exposed for Various Exposure Scenarios

Scenario	US-EPA Recommendations for Percentage Exposed (%)
Swimming and bathing	75–100
Adult outdoor exposure (only head and hands exposed)	10
Adult outdoor exposure (head, hands, forearms and lower legs exposed)	25
Moderate climate, winter	5
Moderate climate, spring and fall	10
Moderate climate, summer	25

Source: US-EPA, 1997, modified from ECETOC, 2001

Table B.6. Default Values of Protection Factor for different Outfits

Description of clothes	Default Protection Factor
Clothing penetration (only for dry substances[a)]) – for a non-professional wearing: long-sleeved shirt and trousers or skirt with shoes; no gloves worn (central tendency)	50% protection
Wearing protective gloves	90% protection
Wearing drya) cotton coveralls	75% protection
Wearing “impermeable” coveralls	95% protection

a) Only for dry substances. Dry is introduced here, since wet cotton coveralls will offer little or no protection.

Table B.7. Percentage of Total Body Surface by Body Part for Children (Genders Combined) and Adults by Gender

Age (years)	Head	Trunk	Arms	Hands	Legs	Feet
	Mean (%)					
Children						
<1	18.2	35.7	13.7	5.3	20.6	6.5
1<2	16.5	35.5	13.0	5.7	23.1	6.3
2<3	14.2	38.5	11.8	5.3	23.2	7.1
3<4	13.6	31.9	14.4	6.1	26.8	7.2
4<5	13.8	31.5	14.0	5.7	27.8	7.3
5<6	-	-	-	-	-	-
6<7	13.1	35.1	13.1	4.7	27.1	6.9
7<8	-	-	-	-	-	-
8<9	-	-	-	-	-	-
9<10	12.0	34.2	12.3	5.3	28.7	7.6
10<11	-	-	-	-	-	-
11<12	-	-	-	-	-	-
12<13	8.7	34.7	13.7	5.4	30.5	7.0
13<14	10.0	32.7	12.1	5.1	32.0	8.0
14<15	-	-	-	-	-	-
15<16	-	-	-	-	-	-
16<17	8.0	32.7	13.1	5.7	33.6	6.9
17<18	7.6	31.7	17.5	5.1	30.8	7.3
Adults						
Men, 18+	7.8	35.9	14.1	5.2	31.2	7.0
Women, 18+	7.1	34.8	14.0	5.1	32.4	6.5

Table B.8. Surface Area of Adults (21+ Years) in Square Meters

Body Part	Men		Women	
	Mean (m^2)	95th Percentile (m^2)	Mean (m^2)	95th Percentile (m^2)
Head	0.136	0.149	0.114	0.121
Trunk (incl. Neck)	0.827	1.020	0.654	0.850
Upper Extremities	0.393	0.456	0.304	0.354
Arms	0.314	0.379	0.237	0.266
Upper Arms	0.172	0.205	-	-
Forearms	0.148	0.181	-	-
Hands	0.107	0.124	0.089	0.106
Lower Extremities	0.802	0.936	0.707	0.875
Legs	0.682	0.811	0.598	0.764
Thighs	0.412	0.495	0.364	0.479
Lower Legs	0.268	0.312	0.233	0.286
Feet	0.137	0.156	0.122	0.146
Total	2.060	2.410	1.850	2.33

Source: Based on US-EPA, 1985 and NHANES 2005–2006, modified from US-EPA, 2009.

15. Annex C.

Inhalation of air – Supplementary Tables

Table C.1. Mean and 95th Percentile Inhalation Rate Values (m^3/day) for Free-living Normal-weight Men and Women

Daily Inhalation Rate – Free-Living Normal-Weight				
	Mean m^3/day		95th Percentile m^3/day	
	Men	Women	Men	Women
Infants:				
1–<3 months	3.38	3.26	4.57	4.36
3–<6 months	3.38	3.26	4.57	4.36
6–<12 months	4.22	3.96	5.51	5.14
Birth to <1 year	3.85	3.64	5.09	4.78
Children:				
1–<2 years	5.12	4.78	6.56	6.36
2–<3 years	7.60	7.06	9.71	8.97
3–<6 years	7.60	7.06	9.71	8.97
6–<11 years	10.59	9.84	13.87	12.61
11–<16 years	17.23	13.28	23.26	17.56
16–<21 years	17.23	13.28	23.26	17.56
Adults (over 21 years):				
21–<31 years	17.36	13.45	22.65	17.50
31–<41 years	16.88	13.68	21.00	16.58
41–<51 years	16.24	12.31	20.64	15.71
51–<61 years	16.24	12.31	20.64	15.71
61–<71 years	14.26	11.21	18.47	14.69
71–<81 years	12.96	9.80	17.03	13.37
≥81 years	12.96	9.80	17.03	13.37

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.2. Physiological Daily Inhalation Rates (m^3/day) for Free-Living Normal-Weight- Unadjusted by Body Weight

Age group (years)	Body Weight[a] (kg) Mean		Physiological Daily Inhalation Rates[b] (m^3/day)			
			Mean (m^3/day)		95th Percentile (m^3/day)	
	Men	Women	Men	Women	Men	Women
0.22–<0.5	6.7	6.5	3.38	3.26	4.57	4.36
0.5–<1	8.8	8.5	4.22	3.96	5.51	5.14
1–<2	10.6	10.6	5.12	4.78	6.56	6.36
2–<5	15.3	14.4	7.60	7.06	9.71	8.97
5–<7	19.8	19.7	8.64	8.22	10.66	10.38
7–<11	28.9	28.3	10.59	9.84	13.87	12.61
11–<23	58.6	50.0	17.23	13.28	23.26	17.56
23–<30	70.9	59.2	17.48	13.67	22.11	17.42
30–<40	71.5	58.7	16.88	13.68	21.00	16.58
40–<65	71.1	58.8	16.24	12.31	20.64	15.71
65–≤96	68.9	57.2	12.96	9.80	17.03	13.37

a) Measured body weight. Normal-weight individuals defined according to the BMI cut-offs.

b) Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(VE/VO2)*10–3, where H = 0.21 L of O2/Kcal, VE/VO2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.3. Physiological Daily Inhalation Rates (m^3/day) for Free-living Normal-weight and Over-weight/obese – Unadjusted for Body Weight

Age group (years)	Body Weight[a] (kg) Mean		Physiological Daily Inhalation[b] (m^3/day)			
			Mean (m^3/day)		95th Percentile (m^3/day)	
	Normal-weight	Overweight/ Obese	Normal-weight	Oveweight/ Obese	Normal-weight	Overweight/ Obese
Men						
4–<5.1	19.0	26.5	7.90	9.59	9.50	11.66
5.1–<9.1	22.6	32.5	9.14	10.88	11.51	14.98
9.1–<18.1	41.4	55.8	13.69	14.52	20.19	17.78
18.1–<40.1	71.3	98.1	17.41	20.39	21.85	26.35
40.1–<70.1	70.0	93.2	15.60	17.96	20.34	24.06
70.1–≤96	68.9	82.3	12.69	14.23	16.53	19.06
Women						
4–<5.1	18.7	26.1	7.41	8.70	8.90	10.56
5.1–<9.1	25.5	34.6	9.39	10.55	12.05	14.22
9.1–<18.1	42.7	59.2	12.04	14.27	16.74	18.71
18.1–<40.1	59.1	84.4	13.73	15.66	17.04	19.13
40.1–<70.1	59.1	81.7	11.93	13.01	15.48	17.64
70.1–≤96	54.8	69.0	8.87	10.00	11.81	12.93

a) Measured body weight. Normal-weight and overweight/obese males defined according to the BMI cut-offs.

b) Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(VE/VO2)*10–3, where H = 0.21 L of O2/Kcal, VE/VO2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.4. Physiological Daily Inhalation Rates (m^3/day) for Free-Living Normal-Weight- Adjusted by Body Weight

Age group (years)	Physiological Daily Inhalation Rates[b] (m^3/kg-day)			
	Mean (m^3/kg-day)		95th Percentile (m^3/kg-day)	
	Men	Women	Men	Women
0.22–<0.5	0.51	0.50	0.66	0.66
0.5–<1	0.48	0.46	0.60	0.57
1–<2	0.48	0.45	0.58	0.58
2–<5	0.44	0.44	0.51	0.56
5–<7	0.42	0.40	0.49	0.47
7–<11	0.37	0.35	0.47	0.45
11–<23	0.30	0.27	0.38	0.35
23–<30	0.25	0.23	0.31	0.30
30–<40	0.24	0.24	0.29	0.29
40–<65	0.23	0.21	0.30	0.27
65–≤96	0.19	0.17	0.24	0.23

a) Measured body weight. Normal-weight individuals defined according to the BMI cut-offs.

b) Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(VE/VO_2)*10–3, where H = 0.21 L of O_2/Kcal, VE/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.5. Physiological Daily Inhalation Rates (m^3/day) for Free-living Normalweight and Overweight/obese – Adjusted for Body Weight

Age group (years)	Physiological Daily Inhalation Rates[b] (m^3/kg-day)			
	Mean (m^3/kg-day)		95th Percentile (m^3/kg-day)	
	Normalweight	Overweight/Obese	Normalweight	Overweight/Obese
Men				
4–<5.1	0.42	0.37	0.49	0.44
5.1–<9.1	0.41	0.35	0.50	0.47
9.1–<18.1	0.33	0.27	0.41	0.33
18.1–<40.1	0.25	0.21	0.31	0.27
40.1–<70.1	0.22	0.19	0.29	0.25
70.1–≤96	0.19	0.17	0.24	0.22
Women				
4–<5.1	0.40	0.34	0.48	0.41
5.1–<9.1	0.37	0.32	0.47	0.43
9.1–<18.1	0.29	0.25	0.38	0.33
18.1–<40.1	0.23	0.19	0.30	0.23
40.1–<70.1	0.20	0.16	0.27	0.21
70.1–≤96	0.16	0.15	0.22	0.19

a) Measured body weight. Normal-weight individuals defined according to the BMI cut-offs.

b) Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(VE/VO_2)*10–3, where H = 0.21 L of O_2/Kcal, VE/VO_2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.6. Physiological Daily Inhalation Rates for Newborns

Age Group	Body Weight (kg)	Physiological Daily Inhalation Rates	
	Mean ± SD	Mean ± SD (m^3/day)	Mean ± SD (m^3/kg-day)
21 days (2 weeks)[a, c]	1.2 ± 0.2	0.85 ± 0.17[f]	0.74 ± 0.09[f]
32 days (~ 1 month)[b, d]	4.7 ±0.7	2.45 ± 0.59[g]	0.53 ± 0.10[g]
33 days (~ 1 month)[a, d]	4.8 ±0.3	2.99 ± 0.47[g]	0.62 ± 0.09[g]

a) Formula-fed infants.

b) Breast-fed infants.

c) Healthy infants with very low birth weight.

d) Infants evaluated as being clinically healthy and neither underweight or overweight.

e) Physiological daily inhalation rates were calculated using the following equation: (TDEE + ECG)*H*(VE/VO2)*10–3, where H = 0.21 L of O2/Kcal, VE/VO2 = 27 (Layton, 1993), TDEE = total daily energy expenditure (kcal/day) and ECG = stored daily energy cost for growth (kcal/day).

f) TDEEs based on nutritional balance measurements during 3-day periods.

g) TDEEs based on 2H2O and H218O disappearance rates from urine.

Source: Brochu et al., 2006a, modified from US-EPA, 2009.

Table C.7. Daily Average Inhalation Rate for Men and Women, by Age Category[a]- Unadjusted by Body Weight

Daily Inhalation Rate – Unadjusted for Body Weight				
	Mean m^3/day		95th Percentile m^3/day	
	Men	Women	Men	Women
Children:				
Birth to <1 year	8.76	8.52	12.69	12.66
1–<2 years	13.49	13.13	17.90	18.62
2–<3 years	13.23	12.74	17.71	16.36
3–<6 years	12.64	12.17	15.41	14.93
6–<11 years	13.42	12.41	17.73	16.34
11–<16 years	15.32	13.44	21.21	17.41
16–<21 years	17.21	13.59	23.37	18.29
Adults (over 21 years):				
21–<31 years	18.82	14.57	27.13	21.14
31–<41 years	20.29	14.98	28.90	20.45
41–<51 years	20.94	16.20	28.37	21.34
51–<61 years	20.91	16.19	29.09	21.21
61–<71 years	17.94	12.99	23.50	16.14
71–<81 years	16.34	12.04	20.42	15.19
≥81 years	15.15	11.15	18.69	13.94

a) Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999–2002 when calculating the statistics in this Table. Inhalation rate was estimated using a multiple linear regression model.

Source: US-EPA, 2009, modified from US-EPA, 2009.

Table C.8. Daily Average Inhalation Rate for Men and Women, by Age Category[a]- Adjusted by Body Weight

Daily Inhalation Rate – Adjusted for Body Weight				
	Mean m^3/day-kg		95th Percentile m^3/day-kg	
	Men	Women	Men	Women
Children:				
Birth to <1 year	1.09	1.14	1.29	1.38
1–<2 years	1.19	1.20	1.48	1.46
2–<3 years	0.95	0.95	1.13	1.10
3–<6 years	0.70	0.69	0.92	0.92
6–<11 years	0.44	0.43	0.58	0.58
11–<16 years	0.29	0.25	0.38	0.34
16–<21 years	0.23	0.21	0.30	0.28
Adults (over 21 years):				
21–<31 years	0.23	0.21	0.32	0.28
31–<41 years	0.24	0.21	0.34	0.30
41–<51 years	0.24	0.22	0.34	0.31
51–<61 years	0.24	0.22	0.34	0.30
61–<71 years	0.21	0.18	0.25	0.22
71–<81 years	0.20	0.18	0.24	0.23
≥81 years	0.20	0.18	0.25	0.22

a) Individual daily averages are weighted by their 4-year sampling weights as assigned within NHANES 1999–2002 when calculating the statistics in this Table. Inhalation rate was estimated using a multiple linear regression model.

Source: US-EPA, 2009, modified from US-EPA, 2009.

Table C.9. Short Term Exposure Inhalation Rates, by Activity Level – Unadjusted for Body Weight

Age (years)	Sleep or Nap		Sedentary/Passive		Light Intensity		Moderate Intensity		High Intensity	
	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min
Men										
0–<1	3.08E-03	4.77E-03	3.18E-03	4.88E-03	7.94E-03	1.19E-02	1.45E-02	2.25E-02	2.75E-02	4.22E-02
1	4.50E-03	6.44E-03	4.62E-03	6.44E-03	1.16E-02	1.58E-02	2.14E-02	2.89E-02	4.03E-02	5.59E-02
2	4.61E-03	6.73E-03	4.79E-03	6.71E-03	1.17E-02	1.53E-02	2.15E-02	2.97E-02	4.05E-02	5.51E-02
3–<6	4.36E-03	5.92E-03	4.58E-03	5.82E-03	1.14E-02	1.40E-02	2.10E-02	2.71E-02	3.90E-02	5.22E-02
6–<11	4.61E-03	6.54E-03	4.87E-03	6.58E-03	1.16E-02	1.56E-02	2.23E-02	2.95E-02	4.36E-02	6.24E-02
11–<16	5.26E-03	7.81E-03	5.64E-03	7.87E-03	1.32E-02	1.87E-02	2.64E-02	3.69E-02	5.08E-02	7.29E-02
16–<21	5.31E-03	7.60E-03	5.76E-03	7.76E-03	1.34E-02	1.80E-02	2.90E-02	4.21E-02	5.32E-02	8.30E-02
21–<31	4.73E-03	6.91E-03	5.11E-03	6.98E-03	1.30E-02	1.77E-02	2.92E-02	4.31E-02	5.39E-02	8.21E-02
31–<41	5.16E-03	7.46E-03	5.57E-03	7.43E-03	1.36E-02	1.81E-02	3.03E-02	4.35E-02	5.43E-02	7.74E-02
41–<51	5.65E-03	7.84E-03	6.11E-03	7.77E-03	1.44E-02	1.83E-02	3.16E-02	4.50E-02	5.73E-02	8.44E-02
51–<61	5.78E-03	8.26E-03	6.27E-03	8.14E-03	1.46E-02	1.94E-02	3.27E-02	4.58E-02	5.84E-02	8.65E-02
61–<71	5.98E-03	7.93E-03	6.54E-03	8.22E-03	1.41E-02	1.80E-02	2.98E-02	4.00E-02	5.41E-02	7.52E-02
71–<81	6.07E-03	8.33E-03	6.65E-03	8.26E-03	1.39E-02	1.69E-02	2.93E-02	3.73E-02	5.25E-02	7.65E-02
≥81	5.97E-03	7.76E-03	6.44E-03	7.90E-03	1.38E-02	1.67E-02	2.85E-02	3.55E-02	5.33E-02	7.71E-02
Women										
0–<1	2.92E-03	4.40E-03	3.00E-03	4.44E-03	7.32E-03	1.08E-02	1.40E-02	2.23E-02	2.42E-02	4.07E-02
1	4.59E-03	6.37E-03	4.71E-03	6.63E-03	1.16E-02	1.58E-02	2.10E-02	2.93E-02	3.65E-02	4.86E-02
2	4.56E-03	6.15E-03	4.73E-03	6.22E-03	1.20E-02	1.63E-02	2.13E-02	2.88E-02	3.76E-02	5.14E-02
3–<6	4.18E-03	5.73E-03	4.40E-03	5.73E-03	1.09E-02	1.38E-02	2.00E-02	2.59E-02	3.45E-02	4.47E-02
6–<11	4.36E-03	6.08E-03	4.64E-03	6.28E-03	1.11E-02	1.47E-02	2.10E-02	2.81E-02	3.94E-02	5.46E-02
11–<16	4.81E-03	6.99E-03	5.21E-03	7.06E-03	1.20E-02	1.58E-02	2.36E-02	3.14E-02	4.66E-02	6.63E-02
16–<21	4.40E-03	6.63E-03	4.76E-03	6.60E-03	1.11E-02	1.49E-02	2.32E-02	3.20E-02	4.41E-02	6.34E-02
21–<31	3.89E-03	6.01E-03	4.19E-03	6.02E-03	1.06E-02	1.43E-02	2.29E-02	3.28E-02	4.57E-02	6.89E-02
31–<41	4.00E-03	5.77E-03	4.33E-03	5.79E-03	1.11E-02	1.39E-02	2.27E-02	3.11E-02	4.44E-02	6.53E-02
41–<51	4.40E-03	6.25E-03	4.75E-03	6.26E-03	1.18E-02	1.45E-02	2.45E-02	3.36E-02	4.70E-02	6.74E-02
51–<61	4.56E-03	6.63E-03	4.96E-03	6.44E-03	1.20E-02	1.49E-02	2.52E-02	3.50E-02	4.74E-02	6.88E-02
61–<71	4.47E-03	6.37E-03	4.89E-03	6.29E-03	1.08E-02	1.32E-02	2.14E-02	2.73E-02	4.00E-02	5.64E-02
71–<81	4.52E-03	6.06E-03	4.95E-03	6.15E-03	1.08E-02	1.30E-02	2.11E-02	2.64E-02	4.06E-02	5.41E-02
≥81	4.49E-03	6.16E-03	4.89E-03	6.12E-03	1.04E-02	1.26E-02	2.09E-02	2.60E-02	4.19E-02	5.83E-02

a) An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999–2002.

Source: US-EPA, 2009, modified from US-EPA, 2009.

Table C.10. Short Term Exposure Inhalation Rates, by Activity Level – Adjusted for Body Weight

Age (years)	Sleep or Nap		Sedentary/Passive		Light Intensity		Moderate Intensity		High Intensity	
	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min	Mean m^3/min	95th m^3/min
Men										
0–<1	3.85E-04	5.03E-04	3.97E-04	4.98E-04	9.88E-04	1.20E-03	1.80E-03	2.18E-03	3.48E-03	4.14E-03
1	3.95E-04	5.24E-04	4.06E-04	5.25E-04	1.02E-03	1.30E-03	1.88E-03	2.34E-03	3.52E-03	4.11E-03
2	3.30E-04	4.42E-04	3.43E-04	4.46E-04	8.37E-04	1.03E-03	1.55E-03	1.84E-03	2.89E-03	3.43E-03
3–<6	2.43E-04	3.50E-04	2.55E-04	3.46E-04	6.33E-04	8.71E-04	1.17E-03	1.56E-03	2.17E-03	2.73E-03
6–<11	1.51E-04	2.15E-04	1.60E-04	2.18E-04	3.84E-04	5.29E-04	7.36E-04	9.58E-04	1.41E-03	1.83E-03
11–<16	9.80E-05	1.41E-04	1.05E-04	1.42E-04	2.46E-04	3.32E-04	4.91E-04	6.35E-04	9.50E-04	1.27E-03
16–<21	7.10E-05	9.80E-05	7.70E-05	1.02E-04	1.79E-04	2.30E-04	3.87E-04	4.86E-04	7.11E-04	9.17E-04
21–<31	5.80E-05	8.30E-05	6.20E-05	8.20E-05	1.58E-04	2.07E-04	3.57E-04	4.68E-04	6.60E-04	8.55E-04
31–<41	6.10E-05	8.60E-05	6.60E-05	8.60E-05	1.61E-04	2.09E-04	3.57E-04	4.71E-04	6.44E-04	8.53E-04
41–<51	6.50E-05	9.20E-05	7.10E-05	9.10E-05	1.66E-04	2.14E-04	3.66E-04	4.69E-04	6.55E-04	8.56E-04
51–<61	6.60E-05	9.30E-05	7.20E-05	9.20E-05	1.67E-04	2.16E-04	3.76E-04	4.82E-04	6.75E-04	9.13E-04
61–<71	6.90E-05	9.30E-05	7.60E-05	9.40E-05	1.64E-04	1.95E-04	3.44E-04	3.99E-04	6.24E-04	7.88E-04
71–<81	7.50E-05	9.90E-05	8.20E-05	9.80E-05	1.71E-04	2.03E-04	3.60E-04	4.18E-04	6.46E-04	8.49E-04
≥81	8.00E-05	1.11E-04	8.60E-05	1.06E-04	1.85E-04	2.24E-04	3.83E-04	4.47E-04	7.16E-04	9.42E-04
Women										
0–<1	3.91E-04	5.17E-04	4.02E-04	5.19E-04	9.78E-04	1.23E-03	1.87E-03	2.40E-03	3.26E-03	4.08E-03
1	4.14E-04	5.36E-04	4.25E-04	5.43E-04	1.05E-03	1.27E-03	1.90E-03	2.37E-03	3.38E-03	4.87E-03
2	3.42E-04	4.53E-04	3.55E-04	4.42E-04	8.97E-04	1.10E-03	1.60E-03	2.02E-03	2.80E-03	3.48E-03
3–<6	2.38E-04	3.53E-04	2.51E-04	3.58E-04	6.19E-04	8.28E-04	1.14E-03	1.56E-03	1.98E-03	2.99E-03
6–<11	1.51E-04	2.29E-04	1.60E-04	2.34E-04	3.82E-04	5.39E-04	7.23E-04	1.01E-03	1.33E-03	1.81E-03
11–<16	9.00E-05	1.30E-04	9.70E-05	1.33E-04	2.25E-04	3.05E-04	4.41E-04	6.11E-04	8.79E-04	1.31E-03
16–<21	6.90E-05	1.02E-04	7.50E-05	1.04E-04	1.74E-04	2.24E-04	3.65E-04	4.94E-04	6.96E-04	1.00E-03
21–<31	5.50E-05	8.20E-05	6.00E-05	8.00E-05	1.49E-04	1.90E-04	3.25E-04	4.52E-04	6.50E-04	9.39E-04
31–<41	5.60E-05	8.20E-05	6.00E-05	8.30E-05	1.54E-04	2.02E-04	3.16E-04	4.60E-04	6.13E-04	9.05E-04
41–<51	6.00E-05	9.00E-05	6.50E-05	9.10E-05	1.61E-04	2.16E-04	3.33E-04	4.88E-04	6.35E-04	9.50E-04
51–<61	6.10E-05	8.80E-05	6.70E-05	9.00E-05	1.61E-04	2.10E-04	3.39E-04	4.86E-04	6.34E-04	9.28E-04
61–<71	6.10E-05	8.10E-05	6.60E-05	8.40E-05	1.47E-04	1.82E-04	2.92E-04	3.71E-04	5.44E-04	8.03E-04
71–<81	6.60E-05	9.00E-05	7.20E-05	9.20E-05	1.58E-04	2.02E-04	3.08E-04	4.07E-04	5.94E-04	8.29E-04
≥81	7.20E-05	9.60E-05	7.80E-05	9.60E-05	1.67E-04	2.08E-04	3.35E-04	4.20E-04	6.66E-04	9.72E-04

a) An individual's ventilation rate for the given activity category equals the weighted average of the individual's activity-specific ventilation rates for activities falling within the category, estimated using a multiple linear regression model, with weights corresponding to the number of minutes spent performing the activity. Numbers in these two columns represent averages, calculated across individuals in the specified age category, of these weighted averages. These are weighted averages, with the weights corresponding to the 4-year sampling weights assigned within NHANES 1999-2002.

Source: US-EPA, 2009, modified from US-EPA, 2009.

16. Annex D.

Drinking Water – Supplementary Tables

Table D.1. Plain Tap Water and Total Water Consumption by Age and Sex

Variable	Plain Tap Water (mL/kg-day) Mean	Total Water (mL/kg-day) Mean
Infants		
<12 months	11	130
12–24 months	18	108
Sex		
Men	15	116
Women	15	119

Source: Heller et al., 2000, modified from US-EPA, 2009.

17. Annex E.

Food Intake – Supplementary Tables

Table E.1. Dietary Habits in Denmark 2003–2008

Group (years)	Mean	90th percentiles
Cheese and cheese products (g/day)		
Boys 4–5	16	31
Boys 6–9	22	47
Boys 4–9	20	41
Boys 10–13	27	54
Boys 14–17	34	56
Boys 10–17	30	59
Men 18–24	48	95
Men 25–34	40	73
Men 35–44	39	72
Men 45–54	41	78
Men 55–64	37	71
Men 65–75	32	62
Men 18–75	39	74
Total (boys and men)	*35*	*70*
Girls 4–5	16	31
Girls 6–9	17	34
Girls 4–9	17	32
Girls 10–13	23	45
Girls 14–17	22	47
Girls 10–17	23	45
Women 18–24	29	51
Women 25–34	30	26
Women 35–44	34	62
Women 45–54	32	57
Women 55–64	29	55
Women 65–75	25	47
Women 18–75	30	54
Total (girls and women)	28	56
All children 4–9	19	37
All children 10–17	26	52
All adults 18–75	34	65
Total (all)	*31*	*62*
Cereals including bread (g/day)		
Boys 4–5	193	248
Boys 6–9	220	310
Boys 4–9	211	290
Boys 10–13	236	334
Boys 14–17	242	350
Boys 10–17	238	334
Men 18–24	252	373
Men 25–34	259	362
Men 35–44	264	377
Men 45–54	245	368
Men 55–64	229	332
Men 65–75	223	328
Men 18–75	245	356
Total (boys and men)	*240*	*349*

Group (years)	Mean	90th percentiles
Girls 4–5	170	227
Girls 6–9	193	262
Girls 4–9	186	249
Girls 10–13	194	266
Girls 14–17	185	282
Girls 10–17	190	270
Women 18–24	187	289
Women 25–34	196	274
Women 35–44	204	295
Women 45–54	180	267
Women 55–64	173	254
Women 65–75	171	250
Women 18–75	187	273
Total (girls and women)	*187*	*272*
All children 4–9	199	276
All children 10–17	212	298
All adults 18–75	214	320
Total (all)	*212*	*314*
Vegetables exclusive potatoes (g/day)		
Boys 4–5	113	201
Boys 6–9	134	230
Boys 4–9	127	219
Boys 10–13	137	257
Boys 14–17	137	238
Boys 10–17	137	251
Men 18–24	158	251
Men 25–34	170	285
Men 35–44	152	254
Men 45–54	153	251
Men 55–64	145	249
Men 65–75	125	223
Men 18–75	150	253
Total (boys and men)	*145*	*249*
Girls 4–5	117	205
Girls 6–9	115	201
Girls 4–9	116	205
Girls 10–13	126	220
Girls 14–17	127	215
Girls 10–17	126	217
Women 18–24	172	292
Women 25–34	182	307
Women 35–44	190	343
Women 45–54	168	277
Women 55–64	166	293
Women 65–75	136	252
Women 18–75	172	297
Total (girls and women)	*160*	*280*
All children 4–9	122	207
All children 10–17	131	230
All adults 18–75	162	278
Total (all)	*153*	*265*
Potatoes and potato products (g/day)		
Boys 4–5	57	109
Boys 6–9	64	133
Boys 4–9	74	140
Boys 10–13	84	176
Boys 14–17	111	222
Boys 10–17	101	215
Men 18–24	113	240
Men 25–34	111	225
Men 35–44	114	218
Men 45–54	123	241
Men 55–64	144	270
Men 65–75	149	263
Men 18–75	126	242
Total (boys and men)	*115*	*231*

Group (years)	Mean	90th percentiles
Girls 4–5	45	104
Girls 6–9	59	114
Girls 4–9	73	137
Girls 10–13	65	147
Girls 14–17	70	141
Girls 10–17	91	184
Women 18–24	67	126
Women 25–34	63	125
Women 35–44	68	126
Women 45–54	81	158
Women 55–64	91	172
Women 65–75	107	182
Women 18–75	100	196
Total (girls and women)	*74*	*146*
All children 4–9	74	139
All children 10–17	95	198
All adults 18–75	112	219
Total (all)	*94*	*189*
Fruits and fruit products (g/day)		
Boys 4–5	197	312
Boys 6–9	189	382
Boys 4–9	274	553
Boys 10–13	176	410
Boys 14–17	136	301
Boys 10–17	234	539
Men 18–24	104	242
Men 25–34	186	405
Men 35–44	160	333
Men 45–54	196	393
Men 55–64	195	422
Men 65–75	201	389
Men 18–75	251	511
Total (boys and men)	*180*	*379*
Girls 4–5	173	296
Girls 6–9	175	302
Girls 4–9	245	456
Girls 10–13	177	343
Girls 14–17	168	358
Girls 10–17	282	541
Women 18–24	187	354
Women 25–34	228	437
Women 35–44	227	436
Women 45–54	241	447
Women 55–64	280	510
Women 65–75	241	431
Women 18–75	311	575
Total (girls and women)	*222*	*431*
All children 4–9	260	469
All children 10–17	274	541
All adults 18–75	283	548
Total (all)	*280*	*541*
Meat and meat products (g/day)		
Boys 4–5	81	117
Boys 6–9	94	139
Boys 4–9	90	134
Boys 10–13	112	173
Boys 14–17	132	212
Boys 10–17	119	192
Men 18–24	147	224
Men 25–34	151	234
Men 35–44	152	261
Men 45–54	140	223
Men 55–64	135	223
Men 65–75	115	178
Men 18–75	140	225
Total (boys and men)	*131*	*213*

Group (years)	Mean	90th percentiles
Girls 4–5	67	102
Girls 6–9	81	121
Girls 4–9	76	117
Girls 10–13	83	128
Girls 14–17	73	126
Girls 10–17	79	127
Women 18–24	78	127
Women 25–34	82	128
Women 35–44	87	136
Women 45–54	84	140
Women 55–64	80	125
Women 65–75	75	123
Women 18–75	82	133
Total (girls and women)	*81*	*130*
All children 4–9	83	126
All children 10–17	97	162
All adults 18–75	109	188
Total (all)	*105*	*179*
Poultry and poultry products (g/day)		
Boys 4–5	14	35
Boys 6–9	17	40
Boys 4–9	16	39
Boys 10–13	23	56
Boys 14–17	23	58
Boys 10–17	23	56
Men 18–24	33	77
Men 25–34	32	74
Men 35–44	28	66
Men 45–54	25	59
Men 55–64	20	50
Men 65–75	20	56
Men 18–75	26	62
Total (boys and men)	*24*	*58*
Girls 4–5	13	30
Girls 6–9	17	39
Girls 4–9	16	37
Girls 10–13	21	46
Girls 14–17	22	51
Girls 10–17	21	47
Women 18–24	23	52
Women 25–34	24	53
Women 35–44	23	48
Women 45–54	21	47
Women 55–64	18	46
Women 65–75	20	42
Women 18–75	21	49
Total (girls and women)	*21*	*47*
All children 4–9	16	37
All children 10–17	22	51
All adults 18–75	23	55
Total (all)	*22*	*53*
Fish and fish products (g/day)		
Boys 4–5	13	30
Boys 6–9	13	32
Boys 4–9	13	32
Boys 10–13	13	33
Boys 14–17	14	31
Boys 10–17	13	32
Men 18–24	14	35
Men 25–34	18	42
Men 35–44	21	49
Men 45–54	23	49
Men 55–64	30	63
Men 65–75	26	54
Men 18–75	23	51
Total (boys and men)	*21*	*46*

Group (years)	Mean	90th percentiles
Girls 4–5	12	32
Girls 6–9	11	28
Girls 4–9	11	30
Girls 10–13	10	23
Girls 14–17	10	24
Girls 10–17	10	23
Women 18–24	16	38
Women 25–34	18	39
Women 35–44	19	45
Women 45–54	20	43
Women 55–64	23	50
Women 65–75	25	52
Women 18–75	20	46
Total (girls and women)	*18*	*42*
All children 4–9	12	31
All children 10–17	11	28
All adults 18–75	22	47
Total (all)	*19*	*44*
Eggs (g/day)		
Boys 4–5	13	22
Boys 6–9	13	26
Boys 4–9	13	26
Boys 10–13	14	31
Boys 14–17	12	27
Boys 10–17	14	30
Men 18–24	13	31
Men 25–34	16	37
Men 35–44	18	37
Men 45–54	18	36
Men 55–64	22	45
Men 65–75	22	48
Men 18–75	19	40
Total (boys and men)	*17*	*36*
Girls 4–5	12	23
Girls 6–9	12	27
Girls 4–9	12	26
Girls 10–13	12	24
Girls 14–17	11	23
Girls 10–17	11	24
Women 18–24	14	32
Women 25–34	16	34
Women 35–44	15	30
Women 45–54	15	32
Women 55–64	17	32
Women 65–75	17	34
Women 18–75	16	32
Total (girls and women)	*15*	*31*
All children 4–9	13	26
All children 10–17	12	28
All adults 18–75	17	35
Total (all)	*16*	*33*
Fats (g/day)		
Boys 4–5	34	53
Boys 6–9	35	57
Boys 4–9	35	55
Boys 10–13	33	56
Boys 14–17	35	59
Boys 10–17	34	57
Men 18–24	39	60
Men 25–34	43	71
Men 35–44	50	87
Men 45–54	42	77
Men 55–64	40	73
Men 65–75	41	75
Men 18–75	43	76
Total (boys and men)	*41*	*71*

Group (years)	Mean	90th percentiles
Girls 4–5	30	53
Girls 6–9	32	53
Girls 4–9	32	53
Girls 10–13	28	48
Girls 14–17	25	41
Girls 10–17	27	46
Women 18–24	29	49
Women 25–34	31	54
Women 35–44	32	52
Women 45–54	27	45
Women 55–64	26	45
Women 65–75	28	48
Women 18–75	29	50
Total (girls and women)	*29*	*49*
All children 4–9	33	55
All children 10–17	30	52
All adults 18–75	35	63
Total (all)	*34*	*60*
Sugar and candy (g/day)		
Boys 4–5	35	62
Boys 6–9	40	72
Boys 4–9	38	69
Boys 10–13	43	82
Boys 14–17	41	93
Boys 10–17	42	85
Men 18–24	32	73
Men 25–34	42	85
Men 35–44	42	84
Men 45–54	33	73
Men 55–64	29	64
Men 65–75	30	61
Men 18–75	35	74
Total (boys and men)	*36*	*75*
Girls 4–5	35	63
Girls 6–9	41	64
Girls 4–9	39	64
Girls 10–13	45	80
Girls 14–17	38	63
Girls 10–17	42	74
Women 18–24	39	68
Women 25–34	39	74
Women 35–44	38	68
Women 45–54	29	60
Women 55–64	25	51
Women 65–75	28	59
Women 18–75	33	64
Total (girls and women)	*35*	*66*
All children 4–9	39	67
All children 10–17	42	78
All adults 18–75	34	69
Total (all)	*36*	*70*
Energy (MJ/day)		
Boys 4–5	7.7	9.4
Boys 6–9	8.8	11.3
Boys 4–9	8.5	11.0
Boys 10–13	9.3	11.8
Boys 14–17	10.1	13.4
Boys 10–17	9.6	12.5
Men 18–24	11.1	15.4
Men 25–34	11.3	14.8
Men 35–44	11.1	15.0
Men 45–54	10.3	13.8
Men 55–64	9.9	13.4
Men 65–75	9.5	13.0
Men 18–75	10.4	14.3
Total (boys and men)	*10.1*	*13.8*

Group (years)	Mean	90th percentiles
Girls 4–5	7.0	8.8
Girls 6–9	7.8	9.8
Girls 4–9	7.5	9.7
Girls 10–13	7.9	10.5
Girls 14–17	7.4	10.5
Girls 10–17	7.7	10.5
Women 18–24	8.2	11.0
Women 25–34	8.3	11.1
Women 35–44	8.3	11.1
Women 45–54	7.6	9.8
Women 55–64	7.5	9.9
Women 65–75	7.4	9.7
Women 18–75	7.9	10.5
Total (girls and women)	*7.9*	*10.4*
All children 4–9	8.0	10.6
All children 10–17	8.6	11.6
All adults 18–75	9.1	12.9
Total (all)	*8.9*	*12.5*

Source: Modified from *Dietary habits in Denmark 2003–2008 – Main Results,* National Food Institute, Technical University of Denmark, (2010).

18. Annex F.

Soil and Dust ingestion – Supplementary Tables

Table F.1. Summary of Estimates of Soil and Dust Ingestion by Adults and Children (0.5-14 years old) from nine key studies (mg/day)

Age (years)	Ingestion medium	Mean	P95	Reference
0.1–<1	Soil	0–30[a]	-	Van Wijnen et al., 1990
1–<5	Soil	0–200[a]	-	
2–<8	Soil	39–246	-	Davis et al., 1990
	Soil and dust	65–268	-	
1–<4	Soil	-294–+459	106–1,903	Calabrese et al., 1989
	Dust	-1,289–+964	160–2,916	
	Soil and dust	-496–+483	159-3,174	
Adult	Soil	23–625	138–2,899	Davis and Mirick, 2006
3–<8	Soil	37–207	95–808	Davis and Mirick, 2006
1–<4	Soil	-544–+270	69–1,378	Calabrese et al., 1997a
<1–<7	Soil and dust	113	-	Hogan et al., 1998
Adult	Soil	50,000[b]	-	Vermeer and Frate, 1979
1–13+	Soil	50,000[b]	-	Vermeer and Frate, 1979
0.3–14	Soil	-	~4,000	Wong, 1988/Calabrese and Stanek, 1993

a) Geometric mean.

b) Average includes adults and children.

Source: Modified from US-EPA, 2009.

19. Annex G.

Life Expectancy – Supplementary Tables

Table G.1. Average Life Expectancy at Birth in 1998, European Countries

Country	Life Expectancy in Years		
	Men	Women	Men and Women Combined
Albania	70	76	73
Armenia	67	74	71
Austria	74	80	77
Azerbaijan	66	74	70
Belarus	62	74	68
Belgium	74	81	78
Bosnia and Herzegovina	71	76	74
Bulgaria	68	75	72
Croatia	69	77	73
Czech Republic	70	77	74
Denmark	73	78	76
Estonia	63	75	69
Finland	73	81	77
France	74	82	78
Georgia	69	77	73
Germany	74	80	77
Greece	76	81	79
Hungary	67	75	71
Iceland	77	81	79
Ireland	74	79	77
Israel	76	80	78
Italy	75	81	78
Kazakhstan	63	72	68
Kyrgyzstan	63	72	68
Latvia	62	74	68
Lithuania	64	76	70
Luxembourg	73	80	77
Malta	75	79	77
Netherlands	75	81	78
Norway	75	81	78
Poland	68	77	73
Portugal	72	79	76
Republic of Moldova	64	72	68
Romania	66	74	70
Russian Federation	61	73	67
Slovakia	69	77	73
Slovenia	71	78	75
Spain	75	82	79
Sweden	76	81	79
Switzerland	75	82	79
Tajikistan	64	70	67
The Former Yugoslav Republic of Macedonia	71	75	73
Turkey	67	72	70
Turkmenistan	62	69	66
Ukraine	64	74	69
United Kingdom	75	80	78
Uzbekistan	64	71	68
Yugoslavia	70	75	73

Source: WHO, 1999b; modified from ECETOC, 2001

Table G.2. Expectation of Life at Birth (in 1996) and from Selected Ages in England

Age (years)	1982	1992	1993	1994	1995	1996
Men						
Birth (0)	71.3	73.7	74.0	74.1	74.4	74.6
5	67.3	69.3	69.6	69.7	70.0	70.2
20	52.7	54.6	54.9	55.0	55.3	55.5
30	43.1	45.0	45.3	45.5	45.7	45.9
50	24.5	26.3	26.6	26.7	27.0	27.1
60	16.5	18.0	18.2	18.3	18.5	18.7
70	10.2	11.2	11.4	11.4	11.6	11.7
80	5.8	6.4	6.5	6.6	6.6	6.7
Women						
Birth (0)	77.3	79.1	79.3	79.4	79.6	79.7
5	73.1	74.6	74.9	74.9	75.1	75.2
20	58.3	59.8	60.0	60.1	60.3	60.3
30	48.5	50.0	50.2	50.3	50.5	50.5
50	29.6	30.9	31.1	31.2	31.4	31.4
60	21.0	22.1	22.3	22.4	22.5	22.6
70	13.5	14.5	14.6	14.6	14.7	14.7
80	7.6	8.4	8.5	8.5	8.6	8.6

Source: UK Government Actuary's Department, 1998, modified from ECETOC, 2001

Table G.3. Average Life Expectancy at Birth in 2008 According to WHO, European Countries

Country	Life Expectancy in Years		
	Men	Women	Men and Women Combined
Albania	71	74	73
Armenia	66	73	70
Austria	78	83	80
Azerbaijan	66	70	68
Belarus	64	76	70
Belgium	77	82	80
Bosnia and Herzegovina	73	78	75
Bulgaria	70	77	73
Croatia	72	79	76
Czech Republic	74	80	77
Denmark	77	81	79
Estonia	69	79	74
Finland	76	83	80
France	78	85	81
Georgia	67	76	72
Germany	77	83	80
Greece	78	83	80
Hungary	70	78	74
Iceland	80	83	82
Ireland	78	82	80
Israel	79	83	81
Italy	79	84	82
Kazakhstan	59	70	64
Kyrgyzstan	62	69	66
Latvia	66	77	71
Lithuania	66	78	72
Luxembourg	77	83	80
Malta	78	82	80
Netherlands	78	82	80
Norway	78	83	81
Poland	71	80	76
Portugal	76	83	79
Republic of Moldova	65	73	69
Romania	70	77	73
Russian Federation	62	74	68
Slovakia	71	79	75
Slovenia	75	82	79
Spain	78	84	81
Sweden	79	83	81
Switzerland	80	84	82

Country	Life Expectancy in Years		
	Men	Women	Men and Women Combined
Tajikistan	66	69	67
The Former Yugoslav Republic of Macedonia	72	76	74
Turkey	72	77	74
Turkmenistan	60	67	63
Ukraine	62	74	68
United Kingdom	78	82	80
Uzbekistan	66	71	68

Source: WHO, 2010.

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Existing Default Values and Recommendations for Exposure Assessment

Default values are often used in exposure assessments e.g. in modelling because of lack of actually measured data. The quality of the exposure assessment outcome is therefore heavily dependent on the validity and representativeness this input data. Today the used default factors consist of a wide range of more or less well-documented values originating from many different sources.

The purpose of this report is to give an overview and to evaluate exposure factors that are currently used by the authorities and industry in the exposure assessments for both adults (occupational and consumer exposure) and children in relation to REACH. Another important purpose of the report is to contribute towards a further harmonisation of exposure factors by giving recommendations of most valid and representative defaults. These recommendations can be used besides REACH also in biocide's and plant protection product's exposure assessments. The exposure default values were collected from the relevant European sources (ECHA, Consexpo, EUSES, Biocide TNsG, ECETOC, ExpoFacts) as well as from WHO and US-EPA. The following key default factors selected to the evaluation: body weight, body surface area, inhalation rate, soil and dust ingestion, drinking water, food intake, non-dietary ingestion factors, lifetime expectancy, activity factors and consumer products

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