Specific Environmental Release Categories (SPERCs) for the formulation of household care and professional cleaning and hygiene products

Background Document

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A.I.S.E., International Association for Soaps, Detergents and Maintenance Products

Boulevard du Souverain 165 - 4th floor

1160 Brussels (Belgium)

www.aise.eu

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1 Statement of purpose

To carry out an environmental exposure assessment, the quantification of the rates of substances released to the environment is key. While ECHA's Guidance R16 (European Chemicals Agency [ECHA], 2016) provides a generic set of release factors (cf. Table R16-7 of the document), they are less meaningful for several industry sectors. Including A.I.S.E., Sector organizations have refined the generic Environmental Release Categories (ERCs) by detailed analysis of the sector's specific typical operational conditions in order to build 'SPecific Environmental Release Categories' (SPERCs).

Thus, the A.I.S.E. SPERCs refine and specify emission scenario information (ERCs) for the use of substances throughout their life cycle (Reihlen et al., 2016) in the detergent and maintenance products industry.

The SPERCs described in this document are specific to the formulation of household and professional cleaning and hygiene products. Yet, they still reflect emission estimates representative for broadly defined formulation processes. They apply for processes which are operated according to common efficient industry practices.

This document provides the background information to the SPERC factsheets for the formulation of household care and professional cleaning and hygiene products, referring to ERC 2 – "Formulation into mixture". In addition to granular, tableted and liquid detergents and maintenance products, this document is also covering a range of solid household and cosmetic products that are manufactured following analogous processes (e.g. bar soaps or scented candles…). ERC 3[1] is not considered because all products described are not considered to build a physically or chemically bound matrix but remain mixtures. This includes candles, where the matrix is not bound, instead candles act as liquids with high viscosity where substances are liberated during use.

Specific information is given as regards the operational conditions of use relevant to exposure in formulation (chapter 2 and 3), the risk management measures (chapter 4), as well as the derivation method and justification of release factors plus indicative use rates (chapter 5).

The SPERC Factsheets covered in this document are:

Table 1: Overview of factsheets covered in the A.I.S.E. SPERCs:

A.I.S.E. SPERC Code	Type of ingredients	Product characteristic	Production Scale
A.I.S.E. SPERC 2.1. a	All substances	Used for the formulation of <u>regular granular and tableted</u> detergents and maintenance products	Large
A.I.S.E. SPERC 2.1. b			Medium
A.I.S.E. SPERC 2.1. c			Small
A.I.S.E. SPERC 2.1. g		Used for the formulation of <u>liquid</u> Detergents/ Maintenance Products: <u>Low Viscosity</u>	Large
A.I.S.E. SPERC 2.1. h			Medium
A.I.S.E. SPERC 2.1. i			Small
A.I.S.E. SPERC 2.1. j		Used for the formulation of <u>liquid</u> Detergents/ Maintenance Products: <u>High Viscosity</u>	Large
A.I.S.E. SPERC 2.1. k			Medium
A.I.S.E. SPERC 2.1. l			Small
A.I.S.E. /CE SPERC 2.3. a		Used for the formulation/production of solid cosmetic and home care products	Large
A.I.S.E. /CE SPERC 2.3. b			Medium
A.I.S.E. /CE SPERC 2.3. c			Small

* All substances = solid + liquid + volatile substances

1 ERC 3 for formulation in materials: Mixing or blending of substances, which will be physically or chemi-cally bound into or onto a matrix (material) such as plastics additives in master batches or plastic compounds.

This background document provides information on the derivation of the relevant parameters of the above-mentioned factsheets. External references are provided in chapter 8. As outlined below, the SPERCs described in this document are conservative for use in lower tier REACH safety assessments. These SPERCs provide generic values for the process but could be further refined providing factory-specific data. The SPERC emission estimates are not intended to reflect all regulatory requirements (e.g. VOC regulation) that may relate to environmental emission thresholds.

2 Scope

Household care and professional cleaning and hygiene products are frequently used in daily life. In homes, these products meet consumers' needs for cleanliness, protection from disease and infection, for comfort, appearance, and pleasure. Household care and professional cleaning and hygiene products present indirect benefits as well. Offices, factories, and schools are cleaner and more pleasant places to work or hospitals pose a lower risk of infection to patients. This SPERC background document is therefore covering the above-mentioned product category and is meant to provide realistic and reliable emission estimation information for the formulation of household care and professional cleaning and hygiene products. The scope of this SPERC comprises products intended for consumer, professional, and industrial applications. Individual compounding steps (= formulation of intermediate products) are not treated in this document. Compounding steps are only in scope if relevant for on-site formulation.

2.1 Product types and their main ingredients

SPERC for ERC 2 covers the formulation of products kept in International Association for Soaps, Detergents and Maintenance Products' portfolio (A.I.S.E., 2013; A.I.S.E., 2019). Each detergent product consists of a variety of ingredients brought together in a formulation. Indicative compositions described here aim to deliver optimal cleaning results (A.I.S.E., 2020). The SPERCs distinguish three product classes:

- **Granular/tableted detergents and maintenance products** are used as laundry detergents (powders and tabs), surface cleaners (powders and tablets) and in machine dishwashing products. The main ingredients of powder/solid detergents are listed on the product package and are comprised of surfactants, builders (zeolites), polymers with various functions and a series of minor ingredients such enzymes, chelators, bleaching agents, fragrance compounds, dyes, etc. Most of these ingredients are non-volatile. Fragrances may contain some volatile and semi-volatile compounds, however.
- **Liquid detergents and maintenance products** are used as laundry detergents, carpet cleaners, surface cleaners (e.g. multi-purpose, bathroom, oven, kitchen, window/glass and floor cleaners, descalers, drain openers, scouring agents, household antiseptics and wipes, in-cistern devices, in the bowl systems (ITBS) and liquids / powders, mousses, tablets and toilet cleaning systems) and in hand dishwashing products. Liquid detergents and cleaners are predominantly based on water, surfactants, polymers, solvents, water and similar minor ingredient, as well as stabilizers/preservatives. Some liquid surfactants can be in the form of a gel or a liquitab ('pod'). In the latter case the product is water-free, and the active ingredients are surrounded by a water-soluble polyvinyl alcohol film (PVA).
- **Solid cosmetics and home care products**:
  Solid cosmetics are used in the form of bath products, solid soap bars or solid form shampoos used for hair, hand and skin cleaning and hygiene products. Solid cosmetic soaps are solid but water-soluble sodium or potassium salts of fatty acids. They are made from fats and oils from both animal and vegetable sources that react with sodium hydroxide. Dyes and perfumes are

often added during that process (Canadian Consumer Specialty Products Association [CCSPA], 2020).

Solid home care products are used in a variety of forms going from bar soaps for cleaning the home to scented candles used as air care products. Household detergent bars are a less common product form (e.g. laundry detergent bars or dish blocks). They present a comparable composition to solid cosmetic soaps. In addition to the soaps and fatty acids, some detergent bars will contain one or more surfactants (CCSPA, 2020).

When it comes to candles, the most commonly used material to produce them is paraffin. Beeswax, soy wax, palm wax, gels, and synthetic waxes are also frequently used in candles. Different blends of these waxes are popular with many manufacturers. Some ingredients like opacifiers, coloring agents, polyethylene, resins, and perfumes are added (Association European Candle Makers [AECM], 2020).

Besides the differentiation among the above three product classes, to obtain adequate emission estimates, a distinction in viscosity should be made for liquid detergents and maintenance products.

The residual fraction is the fraction of a substance that is left in a container after emptying. The residual fraction is (amongst others) dependent on (Royal Haskoning, 2009).:

- Intrinsic properties of the substance (e.g. **viscosity**).
- Container type (e.g. bottle, drum, etc.).
- Method used for emptying the container (pouring, pumping).

The general trend is that the residual fraction increases with:

- Increasing substance viscosity (due to the substance adhering to the container
- surface).
- Decreasing container size (larger surface/volume ratio of smaller containers).
- Pumping instead of pouring as a method of emptying containers, since pumping is an inherently less efficient emptying method.

The viscosity of liquid detergents as well as their constituents may vary from product to product, with low or medium viscosity liquids being respectively like water or syrup. A high viscosity liquid is more like creamy emulsions or a paste. There is no quantitative viscosity cut-off between both product categories. However, high viscosity fluid is operationally defined here as an ingredient in a formulation that will not readily flow out of its container when it is tilted at room temperature. Most cleansers are of low viscosity while liquid detergents can vary from low/medium viscosity to high viscosity (e.g. gel forms).

Consequently, high viscosity liquid products will adhere more strongly to the walls of mixing vessels, tubing, production and packaging lines. They may require different handling during cleaning of production equipment. This can affect the environmental emissions of such materials, as opposed to free-flowing liquid formulations.

2.2 Production Scale

For all three product classes, a distinction is made for production scale. Three scales were defined representing small, medium and large considering both total plant production, and the size of the product type lines. This more granular approach further specifies the SPERC selection process.

The cut-off values for each scale are derived in a weight-of-evidence mode based on 1) existing literature data, 2) expert knowledge and review of recent internal company data, and 3) consideration of data on the yearly volumes of manufacturing of household products in Europe, as collected by the International Association for Soaps, Detergents and Maintenance Products (AISE). The calculation carried out to extract these values is explained in section 5.1, with more details in Annex 3.

A large plant typically consists of multiple production lines for multiple products. For the purpose of this SPERC document, the reported release ratios for large production scale are considered to be valid for large production lines (> 10,000 tonnes per year), reported release ratios for medium production scale are considered to be valid for medium production lines (1,000 - 10,000 tonnes per year). Finally, release ratios for small production scale are extrapolated to < 1,000 tonnes per year.

In case of doubts on what scale to consider, the smaller scale should should always be applied.

2.3 Measurement of Chemical Emissions

For a correct and consistent derivation of the release factors defined in the SPERCs, it is important to understand the underlying modelling framework for manufacturing sites, as described in ECHA REACH Technical Guidance Document R.16 (2016). The release of a substance and subsequent exposure of the environment are in principle assessed on two spatial scales: **locally** in the vicinity of a representative source of the release to the environment, and **regionally** for a larger area which includes all release sources in that area. At the local scale, two release scenarios are distinguished to assess the release to the environment, i.e; for uses taking place at "industrial sites" and for uses taking place in a widespread manner. The life cycle stage of manufacturing is assumed to take place an industrial site. As illustrated in Fig. 16-5 of ECHA TGD R.16 (see Fig. 1 below), the emissions from the plant are assumed to pass via a biological sewage treatment plant (STP) before being released the environment. This STP is a "standard" municipal STP (10,000 i.e, discharge 2,000 m^3/day) by default in the model but can also be an on-site biological treatment plant in case there is no external STP.

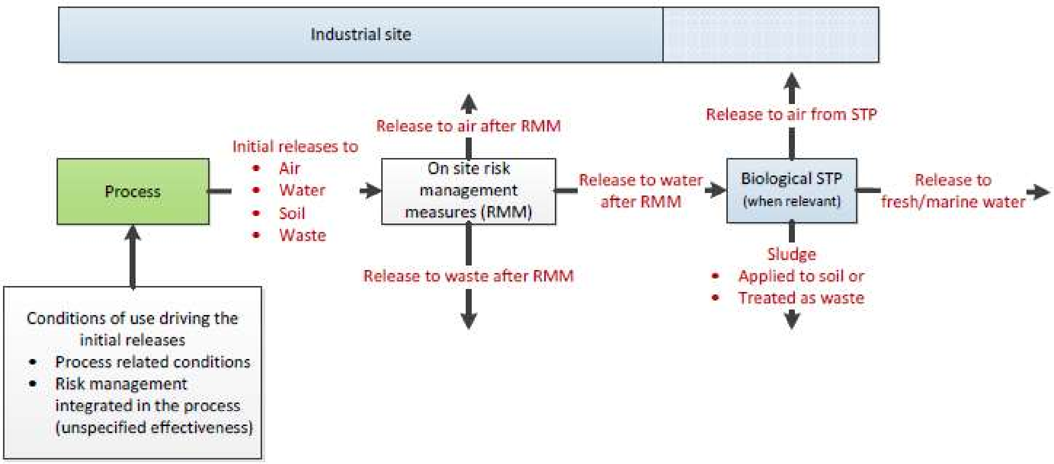

Figure R.16-9: Relationship between the different releases

Figure1 – taken from ECHA REACH Technical Guidance Document R.16 (2016)

Fig R.16-9 further illustrates the modelling framework relevant to the SPERCs. The release factors are intended to reflect the process values, including on-site risk management measures (RMMs), at the point of leaving the site, but before final treatment in a biological STP. For many substances, the process occurring in the municipal sewage treatment plant provide for efficient removal from the wastewater. Nonetheless, the municipal sewage treatment plants are not considered to be a risk management measure in the framework of SPERCs, since they are not under the control of the downstream user. In the exceptional situation that a manufacturing site would have its own biological STP as a RMM, and where the waste water is still further treated by a municipal STP, then the on-site STP can also be accounted for as an additional RMM in the calculations.

To our knowledge, there is not a standard or uniform way to describe material losses (release factors) to the environment from manufacturing in the chemical and/or consumer goods industry. What is exactly measured as analytical parameter may also differ with the compartment of interest (e.g. air, water, waste). In general terms, the SPERCS define the mass of chemicals lost in process/mass of chemicals entering the plant. Since these are both mass units, it is possible to express this ratio as a release fraction (%). A local daily release rate can also be derived from this information.

However, there are very few instances where people responsible for environmental protection at a manufacturing site will do exactly such measurements and calculations unless it is required for the permit or part of process efficiency monitoring. Conclusively, little specific information is available from operations. Instead, their operating permits and environmental reporting duties may require them to track chemical group parameters, e.g. VOCs to air, COD or AOX to water. Solid waste is often split in different material fractions. Therefore, in this SPERC exercise, it was often needed to interpret proxy data, such as e.g. COD, and translate those to average chemical loss fractions.

Other factors that may complicate this type of estimation are:

1) many factories produce a diversity of products on separate productions lines. It is rare that waste waters from production lines are monitored separately
2) measurements to water at 'end-of-pipe' often also include the organic load of grey (kitchen) and black water (toilets)

Hence there is some heterogeneity in the underlying data collected, and the proposed emission factors are the best available approximations.

2.4 Formulation technologies

As previously mentioned, products of the detergent and maintenance (incl. solid cosmetic and home care) category can serve in a large range of applications that is going from large-volume applications such as institutional laundry detergents used on a regular basis to much lower-volume specialties meant for occasional cleaning needs, such as a stain removers.

Soap and detergent manufacturing consists of a broad range of processing and packaging operations. While actual production processes may vary somewhat from manufacturer to manufacturer, there are steps which are common to all products of a similar form (Soap and Detergent Association [SDA], 1994).

Granular cleaning and maintenance products (e.g. powder detergents) are produced by spray drying, agglomeration, dry mixing or combinations of these methods:

- In the spray drying process (Fig. 2), dry and liquid ingredients are initially mixed together into a liquid water-based slurry, in a in a closed mixing tank called a soap crutcher. The slurry is heated prior of being pumped to the upper part of a vertical drying tower where it is atomized (transformed into small droplets) by high pressure spraying through nozzles. "The droplets fall through a current of hot air, forming hollow granules as they dry.
- The dried granules are collected from the bottom of the spray tower where they are screened to achieve a relatively uniform size. After the granules have been cooled, heat sensitive ingredients that are not compatible with the spray drying temperatures (such as bleach, enzymes and fragrance) are added. Traditional spray drying produces relatively low-density powders. New technology has enabled the soap and detergent industry to reduce the air inside

the granules during spray drying to achieve higher densities. The higher density powders can be packed in much smaller packages than were needed previously" (SDA, 1994; CCSPA, 2020).

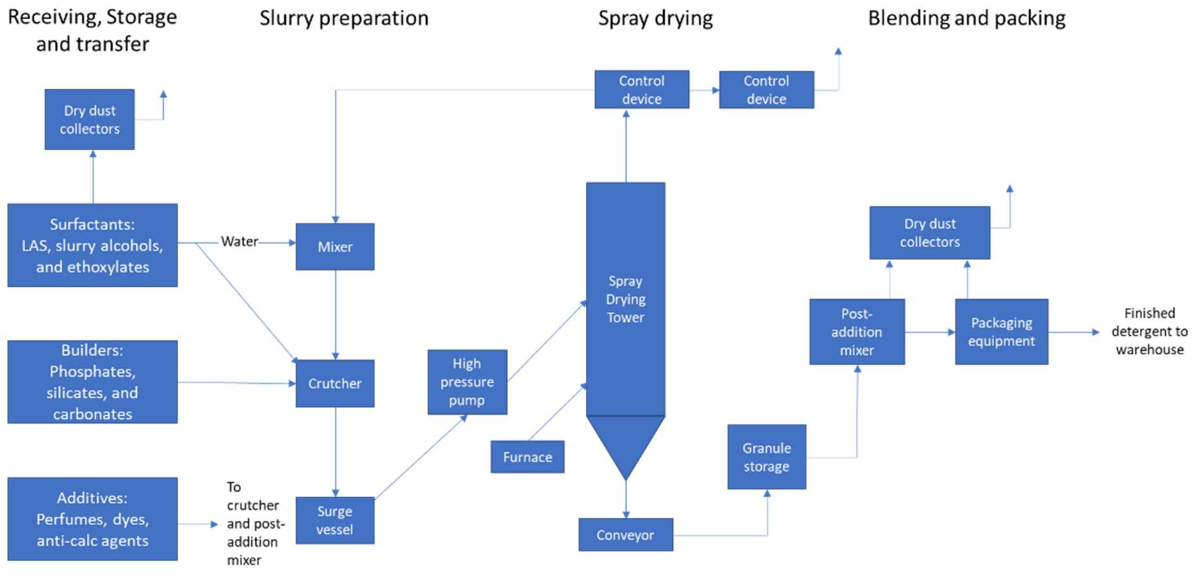

Figure 2 - Typical manufacture of spray-dried detergents (reworked from US EPA, 1993)

- "Agglomeration, which leads to higher density granules and tablets consists of blending dry raw materials with liquid ingredients. Helped by the presence of a liquid binder, rolling or shear mixing causes the ingredients to collide and adhere to each other, forming larger particles. Dry mixing or dry blending is used to blend dry raw materials. Small quantities of liquids may also be added" (CCSPA, 2020).

Liquid detergents and maintenance products are water-borne mixtures manufactured by mixing and pumping the ingredients into mixing tanks. The exact process that is used will depend on the manufacturer and the form of the fined product. Liquid detergents are manufactured either in a batch process or a continuous process. The batch process is the more straightforward since the different constituents are brought in an agitated tank, and further mixing or heating can be provided via a recirculation loop. They are frequently used for specialized products and/or small-scale operations. In comparison, continuous processes are more complex and more adapted to large-scale production. In a continuous process both dry and liquid ingredients are added and then mixed via in-line mixers. The final manufacturing process for liquid detergents is packaging and most of the time implies plastic bottles (SDA, 1994; Joint Research Centre [JRC], 2015). Continuous processes require less cleaning.

Bar soaps: The manufacturing of solid cosmetic and home care products like bar soap consists in four basic steps (JRC, 2015 p139):

- "Step 1 – Saponification: A mixture of tallow (animal fat) and coconut oil is mixed with sodium hydroxide and heated. The detergent produced is the salt of a long chain carboxylic acid.
- Step 2 – Glycerine removal: Glycerine is more valuable than soap, so most of it is removed. Some is left in the soap to help make it soft and smooth.
- Step 3 – Soap purification: Any remaining sodium hydroxide is neutralized with a weak acid such as citric acid and two thirds of the remaining water removed.
- Step 4 – Finishing Additives such as preservatives, colour and perfume are added and mixed in with the soap/detergent and it is packed for sale".

In addition to the described process, solid detergents like soap bars usually incorporate a variety of other ingredients that act as water softeners, free-flowing agents, etc. The below process flow diagram indicates the general flow of plant processes and equipment involved in the formulation/production of solid cosmetic products like bar soap (Fig. 3):

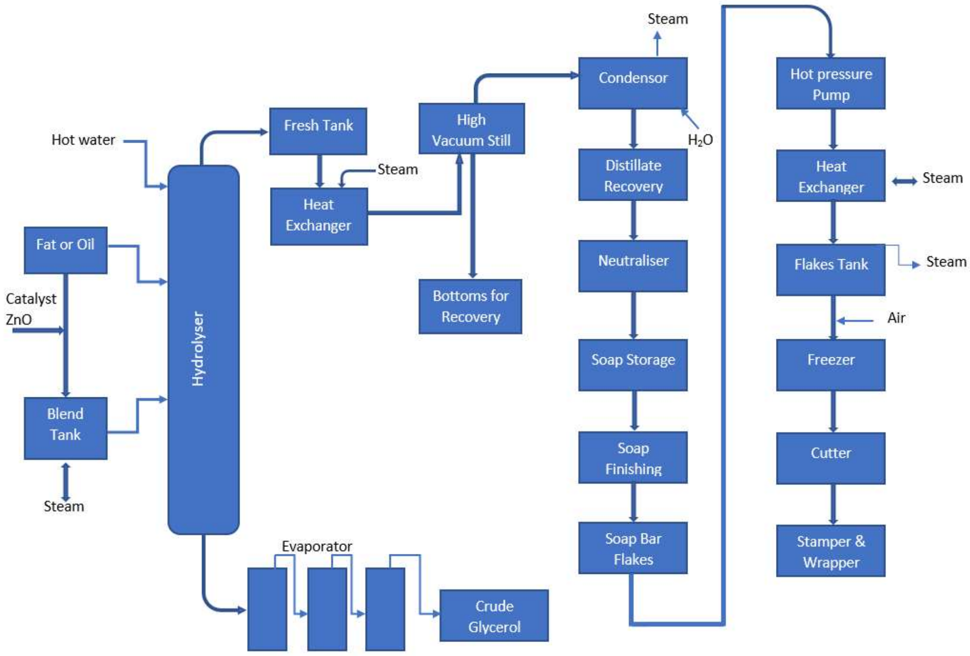

Figure 3 – continuous process of fatty acids and soaps production (reworked from US EPA, 1993)

Scented candles: the manufacturing process employed for the formulation/production of solid home care products like scented candles consists in three main steps: the first one is the preparation of the wick, the second one is the preparation of the wax, and the third one is the production of the finished product through either a continuous molding process or through an extrusion process.

Many candle makers are using continuous candle molding or candle drawing machines. During these processes, the wax is poured in metallic molds that present a polished interior surface for easier ejection of the finished candle. Once the wax has solidified, the finished candles are detached from the molds. Surplus of wax is removed, recovered and re-used (European Candle Association [ECA], 2020; AECM, 2020).

Another common candle making method is using an extrusion procedure. Here, the wax is pressed through a heated, cylindrical tube from which a continuous ribbon of the still malleable candle is issued. On the contrary of molding machines, extrusion machines produce a continuous length of candle, which is then cut into specific sizes (Willhöft and Horn, 2000; AECM, 2020).

3 Emission relevance of operational conditions

The formulation of household care and professional cleaning and hygiene products is subsumed into eight common process steps with regard to potential releases into the environment. These include (a) transfer of substances from containers into storage or mixing vessels (b) container cleaning or (c) direct disposal of empty containers, (d) the formulation/mixing step, (e) product quality sampling, (f) the packaging or filling of the product and finally (g) the equipment cleaning and (h) disposal of off- spec material. Emissions occurring during these operational processes can be differentiated into material loading emissions, evaporation, filling losses and all kinds of miscellaneous cleaning operations (Based on US EPA, 1993; Organisation for Economic Co-operation and Development [OECD], 2009; Association of the European Adhesive & Sealant Industry [FEICA], 2017).

Table 2 : Overview of the processing steps involved in household care and professional cleaning and hygiene products, and their relevance with regards to the emission estimation and derivation of release factors.

Processing Step		Formulation of granular Detergents/Maintenance Products	Formulation of liquid Detergents/Maintenance Products		Formulation of solid cosmetic and home care products
		regular granular and tableted	Low viscosity	High viscosity	solid
A.I.S.E. SPERC		A.I.S.E. SPERC 2.1. a-c	A.I.S.E. SPERC 2.1. g-i	A.I.S.E. SPERC 2.1. j-l	A.I.S.E. /CE SPERC2.3. a-c
a	Transfer of substances	• Automated or manual transfer of liquids to formulation vessel does not result in emissions to environment. • Some open surface losses of volatile chemicals to air during container cleaning. Volatiles are controlled through the introduction of retrieval/recycling equipment and the introduction of airtight equipment. • Dust emissions during loading operations of solid raw materials. Good practice is the installation of air extraction systems with dust filters (implemented in release factors). • Use of robotics technology, closed transfer systems and master batches for larger production scales.			
b	Container and tube cleaning	• Transport containers may be cleaned off site by a third party. For the SPERC estimation the container residues are disposed by the receiving formulating facility, either by being rinsed from the container or the empty container being discarded directly into an off-site landfill.			
c	Direct disposal of empty containers	• Empty containers shipped to offsite treatment, storage, or disposal (through high temperature incineration) – low emissions to the environment (Food and Agriculture Organization of the United Nations [FAO], 2008).			
d	Formulation/ mixing	• Exhaust air from detergent spray drying towers: fine detergent particles and organic material losses to air during mixing operations. These emissions are minimized by having tight specifications on what can be added as primary detergent active material. Any potentially hazardous materials are added with the secondary actives after the tower so that it is not heated. Spot checks are done on the total hydrocarbon content of the exhausted gases using a flame ionization detector. • Dust emissions during loading operations of solid raw materials. Good practice is the installation of dry cyclones and cyclonic impingement scrubbers as primary collection equipment. Secondary collection equipment is mist eliminators, and fabric filters or scrubber/electrostatic precipitator units.	• Mostly closed batch mixers with automated or manual transfer of raw materials. The Air Pollution Problem is related to the receiving, storage and batching of the various dry ingredients that can create dust emissions prior to mixing in water. Losses to air prevented with dust filters.		• Mostly closed batch mixers with pneumatic transfer of raw materials. Blending, mixing, drying, packaging and other physical operations may all involve particulate emissions. • Dust emissions can be controlled by dry filters such as baghouses (Fig. 4). A baghouse, also known as a baghouse filter, bag filter, or fabric filter is an air pollution control device and dust collector that removes particulates or gas released from commercial processes out of the air.
e	Product quality sampling	• Negligible amount of sampling as compared to total factory production. Product sampling wastes disposed to water, incineration or landfill.			
f	Packaging and/or filling	• The packaging of granular or solid household care and professional cleaning and hygiene products causes in-plant dust emissions which are generally controlled by baghouses. No transfer operation losses of volatile chemicals to the air. The packaging of liquid products is not known to cause any type of emissions.			
g	Equipment cleaning	• Equipment cleaning with minimized emissions to wastewater may include: ○ Dry cleaning of equipment, use of Central or Peripheral Vacuum Cleaning or manual removal of residual products (e.g. by scrubbing) and/or ○ Cleaning involving so-called 'pigs' in sub-processes involving liquid slurries re-use of process grey water for cleaning, use of two-liner systems (i.e. single use disposable reactor cover that is incinerated after use as solid waste) ○ Use of adsorption pads to clean liquid spills			
h	Disposal of off-spec products	• What cannot be recycled into the process will become waste that needs to be disposed of. Liquid waste is typically directed to wastewater, while solid waste can be treated as industrial waste and is incinerated. Since waste is an economic factor it is always minimized as much as possible.			

Environmental release of substances is also controlled through the operational conditions of the production processes that are generally optimized for highly efficient use of raw materials. Typical improvement measures for large production sites may include the adoption of practices such as:

- ✓ the use of closed and automated production processes (i.e. with negligible emissions to air)
- ✓ the use of centralized process controls
- ✓ the use of optimized and automated systems for the transport and handling of raw materials, that minimize overall exposure levels and incidental spills
- ✓ the use of a reduced number of transfer and cleaning operations through, for instance, the manufacturing of different products from one premix (masterbatch), to which certain ingredients are added to yield the final products
- ✓ the use of dedicated storage tanks for raw materials, premixes and final products
- ✓ the recovery of materials through, for instance, the recycling of residues of granular detergents in cleaning steps at packaging or transfer lines into the slurries, and from filters.
- ✓ the re-use of process grey water for cleaning

While large-scale operations have many (not all) of the above measures in place, medium and smaller operations may include less of these practices. It is key to note that while the SPERC factsheets provide tonnage bands that distinguish between small, medium and large manufacturing sites, what is actually key to consider are the measures implemented on site for efficient raw material use.

Blending, mixing, drying, packaging, and other physical operations of powder products are subject to the air pollution problems of dust emissions. Dust emissions from equipment used in operations other than spray drying can be controlled by dry filters and baghouses. Moisture content of the dust-laden air is well below saturation and close to ambient so that condensation in the baghouse is not a problem. Dust collected in filters or baghouses can be recycled to the process (US EPA, 1973).

The operation that is most common to the formulation of all product types, and that may lead to the most significant product losses, is the equipment cleaning. Related environmental releases are kept under control by the implementation of general good practices in the detergents industry. These general good practices imply, amongst other, that residues of granular detergents recovered in equipment cleaning steps at packaging or transfer lines are recycled into the slurries. Within this context, typically implemented measures for reducing emissions to wastewater may include:

- ✓ Manual removal of residual products adhering to equipment (e.g. by manual scrubbing, vacuum cleaning, etc.)
- ✓ use of two-liner systems (i.e. single use disposable reactor cover that is incinerated after use as solid waste)
- ✓ Typical measures may include e.g.
    - o Closed batch systems and / or
    - o Semi-closed transfer system and/or
- ✓ Use of master batches (mainly in large and medium scale operations)
- ✓ Batch production of final product (mainly in medium and small operations)
- ✓ Reduced number of transfer and cleaning operations through e.g.
- ✓ Dedicated storage tanks for raw materials, premixes and final products

Lower emissions of larger plants are also driven by economic considerations and materials efficiency, to ensure that cleaning residues and spills are reused to a maximum extent by reblending them into the process. Material losses > 1 % for well-established detergent and cleaner production processes would be deemed as poor industrial practice with a negative impact on profitability and sustainability. This is true also for small scale operations, but becomes even more significant at larger scales. In case of doubts, the most conservative values should always be assumed/applied.

The emissions typically associated with the processes are described below for the major product categories:

- **Granular detergents**

During formulation of granular detergents, some emission of ingredients or products cannot be avoided. Emissions to water could originate from regular cleaning and maintenance of production equipment, or from occasional spills. Emissions could occur at different stages of production such as transportation of raw materials, raw materials' storage in dedicated areas or raw materials' transfer within the production site. These emissions can be controlled with appropriate risk reduction measures that are described further in this document. During formulation of granular detergents, emissions to water are expected to be higher than the emissions to air, soil or waste.

During the formulation of granular detergents (spray drying process), it is expected that the main emissions to the air would originate from the exhaust air from detergent spray drying towers since it may contain fine detergent particles and organics vaporized in the higher temperature zones of the tower. Note that in Europe, the traditional spray dried product forms have been largely replaced by other (often better performing) product forms, like Single Unit Dose Laundry Detergents, Liquid Laundry Detergents or Gel Laundry Detergents leading to less air emissions.

Dust emissions are occurring at scale hoppers, mixers, and crutchers during the batching and mixing of fine dry ingredients to form the slurry. Conveying, mixing, and packaging of detergent granules can also cause dust emissions. Fabric filters are generally used, not only to reduce or to eliminate dust emissions from ambient air (e.g. to ensure regulatory requirements), but also to recover raw materials.

During operations, dry cyclones and cyclonic impingement scrubbers are the primary collection equipment employed to capture the detergent dust in the spray dryer exhaust for return to processing. Secondary collection equipment like mist eliminators or fabric filters or scrubber/electrostatic precipitator units are used to collect fine particulates that escape from primary devices (US EPA, 1993).

In addition to particulate emissions, volatile organics may be emitted when the slurry contains organic materials with high vapor pressures. The VOCs originate primarily from the surfactants included in the slurry. These vaporized organic materials condense in the tower exhaust airstream into droplets or particles. Paraffin alcohols and amides in the exhaust stream can result in a highly visible plume that persists after the condensed water vapor plume has dissipated (Phelps, 1967; US EPA, 1973).

In some cases, the waste can be recycled into the process. Non-recyclable solid industrial waste is sent for incineration and accounted for by the release factor to waste.

- **Liquid detergents**

Liquid detergents are manufactured either in a batch process or a continuous liquid production (CLP) process. These are typically closed systems. There is no evidence of significant air emissions from the production of liquid detergents (US EPA, 1980). From an air pollution standpoint, the major area of interest is the spray drying of synthetic detergents (Phelps, 1967). Emissions to water from liquid detergent manufacturing originate from regular cleaning and maintenance, or from occasional spills. In some cases, the waste can be recycled into the process. In any way, wastes from these processes is incorporated into the release factors to water.

- **Solid cosmetic and home care products**

  "During the formulation of solid cosmetic and home care products the main atmospheric pollution problem is odor compounds. The storage and handling of liquid ingredients (including sulfonic acids and salts) and sulfates are some of the sources of this odor. Vent lines, vacuum exhausts, raw material and product storage, and waste streams are all potential odor sources. Control of these odors may be achieved by scrubbing exhaust fumes and, if necessary, incinerating the remaining volatile organic compounds (VOCs)" (US EPA, 1993).

"Blending, mixing, drying, packaging and other physical operations may all involve particulate emissions. The production of soap powder by spray drying is the single largest source of dust in the manufacture of synthetic detergents. Dust emissions from other finishing operations can be controlled by dry filters such as baghouses (Fig. 4). The large sizes of the particulate from soap powder operations means that high efficiency cyclones installed in series can achieve satisfactory control" (US EPA, 1993).

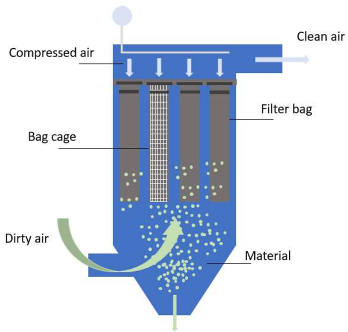

Figure 4 – Example of Baghouse dust collector (air pollution control device)

The only origin of releases to water are equipment cleaning and maintenance operations.

No direct exposure of detergent ingredients to soil is to be expected during normal manufacturing operations (Royal Haskoning, 2009). In total, only a very small fraction of the substances ends up in the waste stage. Any disposal leading to emissions is covered in the exposure assessment and is accounted for in the emission factor.

4 Application of risk reduction measures

There are several separate and distinctive processes that are taking place during formulation of household care and professional cleaning and hygiene products. Emission reduction measures may be required during formulation of such products. It is assumed that the abatement techniques mentioned in chapter 3 are generally known and applied by industry in this sector, where appropriate, as "good industry practice". Hence, the emission reduction by these techniques either in solidity, in combination or in its entity, is already incorporated in the reported emissions by the given release factors, respectively. Hence, it is noted that they are already part of the operational conditions and include in the release factors. Therefore, there are no specific risk reduction measures mentioned in this chapter.

All chemical processes and some of the other operations involved in the making of household care and professional cleaning and hygiene products, unless operated in completely closed systems, have odors as a common air pollution problem. The final elimination of odors from the manufacture of household care and professional cleaning and hygiene products can be accomplished by scrubbers, such as water ejectors of barometric condensers. The odor-containing gases vented from this scrubber are in very low volumes. The residual odors are diluted in the atmosphere well below their threshold levels in traveling through the atmosphere for only a short distance from the Scrubber exhaust (US EPA, 1973).

Operational conditions leading to waste reduction are supported by comprehensive worker environmental and safety training programs. Trained staff can implement spill protection procedures. Finally, biological treatment of wastewater by municipal sewage treatment plants (STP) is generally required but are outside the scope of the SPERCs exposure parameter, i.e. release factor.

5 SPERC Information sources and justification

The derivation of the release factors is based on literature and data collected from industry associations.

- **Granular Detergents / Maintenance Products:**

Emissions to water: three key documents have been consulted to define these release factors. The first document has been published in 2009 by Royal Haskoning in a report commissioned by the Research Institute of Fragrance (Royal Haskoning, 2009). This report describes the operational conditions and environmental exposure scenarios during the formulation of fragrance preparations and their incorporation into household and personal care products. The second and the third documents consulted for the derivation of the release factors to water are based on inventory data from Life Cycle Assessments (Franke et al., 1995; Saouter et al., 2002). Some recent release factor data for 6 plants from a A.I.S.E. member company have also been included. The release factor data from the 6 A.I.S.E. plants is data on release values prior to STP, in line with the data required for the SPERCs.

Emissions to air: three documents published by the United States Environment Protection Agency have mainly been consulted to derive granular detergents industry's release factors to air.

The first document is the "Compilation of Air Pollutant Emissions Factors" in its 1993 edition. This compilation contains emissions factors and detailed process information for amongst other the Soap and Detergents industry sector. The related emissions factors have been developed and compiled from source test data, material balance studies, and engineering estimates. Its chapter 6.8 is specifically dedicated to the Soap and Detergents industry (US EPA, 1993).

The second document is the "Source Category Survey: Detergent Industry" that was published in 1980 and that describes the processes and emissions from the soap and detergent industry (US EPA, 1980).

The third effective document is the "Air Pollution Engineering Manual" published in 1973. This manual deals with the control of air pollution at specific sources. This manual emphasizes the practical engineering problems of design and operation associated with the many sources of air pollution, one of them being the Soap and Detergents industry (US EPA, 1973).

These three documents provide detailed descriptions of the manufacturing and industrial use processes for household care and professional cleaning and hygiene products and do contain air release factors related to the production of detergents.

In addition to the previously mentioned US EPA sources, a Life Cycle Analysis (LCA) was used to analyze material flow in the laundry detergent sector (Franke et al., 1995). Data in this study were collected for the Germany detergent industry.

Emissions to soil: A report published by Royal Haskoning in 2009 has been consulted to define detergents industry's release factors to soil (Royal Haskoning, 2009).

Emissions to waste: The 2009 Royal Haskoning report has been consulted to derive detergents industry's release factors to waste (Royal Haskoning, 2009) as well as an LCA analyzing material flow in the laundry detergent sector (Franke et al., 1995).

- **Liquid Detergents/ Maintenance Products:**

Emissions to water: A report published by Royal Haskoning in 2009 has been consulted to define liquid detergents industry's release factors to water (Royal Haskoning, 2009).

Emissions to air: two documents have been consulted to derive liquid detergents industry's release factors to air. The first one is the "Source Category Survey on Detergent Industry" that was published in 1980 (US EPA, 1980). The second document is a peer reviewed LCA conducted for the laundry detergent sector in western Europe (Franke et al., 1995).

Emissions to soil: The Royal Haskoning report from 2009 has been consulted to derive detergents industry's release factors to soil (Royal Haskoning, 2009).

Emissions to waste: The 2009 Royal Haskoning report has been consulted to define detergents industry's release factors to waste (Royal Haskoning, 2009).

- **Solid cosmetic and home care products:**

Emissions to water: The Royal Haskoning report has been consulted to derive detergents industry's release factors to water (Royal Haskoning, 2009).

Emissions to air: two sources have been consulted to derive solid cosmetic and home care product's industry release factors to air. The first one is a document that has been published by the US EPA and consists in a report named "Source Category Survey on Detergent Industry" (US EPA, 1980) while the second source is information communicated by the Association of European Candle Makers (AECM, personal communication, 2020) that represents candle manufacturers and suppliers to the candle industry in Europe.

Emissions to soil: The Royal Haskoning report has been consulted to derive detergents industry's release factors to soil (Royal Haskoning, 2009).

Emissions to waste: The Royal Haskoning report has been consulted to derive detergents industry's release factors to waste (Royal Haskoning, 2009).

5.1 Justification of use rates

Data on the composition of detergents and maintenance products can be found on the cleanright.eu consumer portal (cleanright.eu, 2020). Based on these compositions, indicative ingredient use rates can be estimated for typical large- medium- and small-scale formulation sites.

M_{SPERC}'s can be used by a registrant when starting the environmental assessment. M_{SPERC} represents an indicative worst-case value for the substance use rate per site. The derivation of the M_{SPERC}'s is explained in Annex 1 of this document while typical substance use rate M_{SPERC}'s for Industrial use in formulation of liquid cleaning and maintenance products can be found in Annex 2.

Derivation of production scale estimation for detergent products

The A.I.S.E. Activity & Sustainability report (A.I.S.E, 2019) comprises circa 85% of total EU production for both the homecare and professional sectors that amounts to 11.3 million tonnes in 2019. Based on that fact, the total production for the sector is estimated to be equal to 13.3 million tonnes annually.

The deduction of large, medium and small production scales for the SPERCs derived from the above figures. For further details please refer to Annex 3. However, because companies are producing different product categories at one site, i.e. comprising of more than just one production lines, the tonnage figures per production line are smaller as predicted per large company. In that context, cutoff value for individual product lines' production have been leveraged. The following production scales were derived by expert judgment:

- large scale production line → > 10,000 tonnes product* per year,
- medium scale production line → 1,000 - 10,000 tonnes product* per year,
- small scale production line → <1,000 tonnes product* per year.

Thus, if data is available, the production line size will be considered the most relevant criteria for defining the SPERC to select. However, if this is not available, then whole factory data can be used to define the scale of the plant. In case of doubts on what scale to consider, the smaller scale should should always be applied.

Derivation of production scale estimation for solid cosmetic and home care products with specificity for candles:

Information on solid cosmetics products can be found in the background document for the SPERCs created by Cosmetics Europe.

Specifically for candles, A.I.S.E. connected with the experts of the European candle manufacturer association. The following data was shared to note: European market for candles (paraffin, stearin and wax candles) saw a general increase in production from 467,935 tonnes in 2005 (Nordic Ecolabelling, 2014) to 740.000 tonnes in 2018 (ECA, 2019). Yet, production scales of detergents are 10-fold higher than the production of solid cosmetic and home care products.

5.2 Justification of days emitting.

The justification of the emission days is a reasonable worse case value for large industrial sites, operating at > 300 days a year. Many large plants operate non-stop (365/7/24 – information from company experts). The 300 days per year allows a buffer to account for eventual plant closure during holidays, and days for maintenance where operations are forced to be stopped or limited.

The number of emitting days for large and medium industrial sites is corresponding to emitting days referenced by the European Chemicals Bureau (ECB) in the B-tables for chemical formulation processes found in the Technical Guidance Document on Risk Assessment (Part II: Environmental Risk Assessment) (ECB, 2003a). Following this guidance document, the number of emission days per year for small sites has been determined to be 150 days (ECB, 2003a, table B2.4 for non-HPVC - page 249).

5.3 Justification of release factors

Prior to the development of the A.IS.E. SPERCs, the regulatory guidance on emission scenarios for different life cycle stages, including the formulation stage, could be found in ECB's Technical Guidance

Document on Risk Assessment (Part II) (ECB, 2003a). The values for formulation were listed in table A2# found in APPENDIX I of that document at the page 226. The Release Factors in table A2# were mainly based on data from Franke et al. (1995), as also listed in ECB's Technical Guidance Document on Risk Assessment (Part IV: Emission Scenario Documents) (ECB, 2003b).

In the period 2007-2009, a group of A.I.S.E. and Cosmetics Europe experts reassessed available release factor data, and issued a series of SPERC fact sheets that have been used by industry in the REACH Phase 1 to 3 registrations in the period 2010-2018. These SPERC fact sheets had been made publicly available on the A.I.S.E. website.

The general approach that has been followed is to define the Release Factors (RF) as the observed emissions amounts to air/water/soil/waste in relation to the volume of produced finished product (i.e. Mass/Mass), and converted to percent, for the overall process or production line (cf. section 2.3).

As suggested by Reihlen et al. (2016), different approaches and information sources were consulted in this background document, sometimes in a weight of evidence approach, to derive the most appropriate and representative release factors. These approaches include 1) extraction of release factors from literature, 2) data collected of cross-checks done in the sector, and 3) qualitative argumentation based on thorough process and plant operations management understanding. Scaling (read-across) was also used to bridge between different plant sizes.

The ratios between the environmental release factors of small, medium and large size plants, have mainly been extrapolated from the data referred in the Royal Haskoning report (Royal Haskoning, 2009). The Royal Haskoning report (2009) contains estimates of the environmental emission scenarios for fragrance materials during compounding of perfume oils and formulation of consumer products (p. 3). This was operationally defined based on the measurements of achievable emissions and applied technologies in highly automated large production scale plants of detergents with full process equipment and spill control measures vs. smaller size operations.

It displays empirical release ratios for large and medium production volumes, whereby 'large' describes total production volumes for liquid cleaners, conditioners, shampoos, and shower gels above 100,000 tonnes per year and 'medium' for total production volumes above 10,000 tonnes per year. This was operationally defined based on the measurements of achievable emissions and applied technologies in highly automated large production scale plants of detergents with full process equipment and spill control measures vs. smaller size operations.

Table 4 provides a summary overview of the RF presently (year 2021) recommended by A.I.S.E. for use in its SPERCs. There are a few small changes suggested versus the previous versions, based on new insights from the literature and recent data validation within companies. In the footnotes underneath the table we provide some more perspective regarding the choice of data. Data in the table are identical to those previously published (i.e. until 2021), unless indicated.

Table 3: Summary of release factors for the SPERCs for the formulation of household care and professional cleaning and hygiene products.

A.I.S.E. SPERC Code	Product characteristic	Production Scale (products)	Release Factors			
			To air	To water	To soil[3]	To waste[4]
A.I.S.E. SPERC 2.1. a	regular granular and tableted products	Large	0.1%[1]	0.05%[8]	0%	0-6%
A.I.S.E. SPERC 2.1. b		Medium	0.1%[1]	0.1%	0%	0-6%
A.I.S.E. SPERC 2.1. c		Small	0.1%[1]	0.2%	0%	0-6%
A.I.S.E. SPERC 2.1. g	liquid products of low viscosity	Large	0%[2]	0.05%[8]	0%	0-6%
A.I.S.E. SPERC 2.1. h		Medium	0%	0.1%	0%	0-6%
A.I.S.E. SPERC 2.1. i		Small	0%	0.2%	0%	0-6%
A.I.S.E. SPERC 2.1. j	liquid products: high viscosity	Large	0%	0.1%	0%	0-6%
A.I.S.E. SPERC 2.1. k		Medium	0%	0.2%	0%	0-6%
A.I.S.E. SPERC 2.1. l		Small	0%	0.4%	0%	0-6%
A.I.S.E. /CE SPERC 2.3. a	solid home and cosmetic products	Large	0.006%[5]	0.05 %[6]	0%	0-6%
A.I.S.E. /CE SPERC 2.3. b		Medium	0.006%	0.1%[7]	0%	0-6%
A.I.S.E. /CE SPERC 2.3. c		Small	0.006%	0.2%	0%	0-6%

1. This value was zero in the previous version of the A.I.S.E. SPERC (versions prior to 2020). The new number is derived from US EPA Source Category Survey (US EPA, 1980) and is matching with data in Franke et al. (1995). Value was 0.11% and has been rounded to 0.1%.
2. Air emission for batch and CLP processes are negligible (cf. Section 4)
3. It is assumed that there is no waste to soil surrounding the plant. All chemical waste that cannot be recycled or treated via the sewage treatment infrastructure will be collected by a professional waste handler and incinerated in a specialized installation.
4. This waste fraction relates to the chemicals that may remain in the transport containers
5. Data shared by Candle Makers Association in December 2019 with AISE SPERC Task Force.
6. Large scale production of hard soaps from the Royal Haskoning report (2009).
7. Equally to the detergents, a factor 2 has been kept between medium and small production scales of solid home and cosmetic products.
8. A.I.S.E. company plant data included - confidential

5.4 Justification of Risk Management Measures

RMM and emission control technologies for the detergent and cleaning manufacturing operations are generally following "good industry practice". They are described in general terms in sections 3. Ch 4 further defines elements of the practice, while no additional mandatory RMM is deemed necessary for the purpose of the SPERCs. Therefore, the use of data on efficiencies of individual RMM or equipment performance is not considered in this approach.

6 Conservatism

As outlined in the European Chemical Industry Council (CEFIC) guidance (CEFIC, 2010, 2012), SPERCs are intended to provide realistic but conservative emission estimates (Reihlen et al, 2016). Normally, an (average) realistic worst-case value was taken from the whole of data pool collected.

In addition, and more generally, the use of historical emission information for the RF derivation may contribute to conservatism because those emissions are likely higher than current emissions as a result of ongoing innovation and regulation, thus increasing process efficiency and emission reductions over time (Reihlen et al, 2016). It can be assumed some literature date (e.g. from US-EPA collected in the seventies), are not fully representative anymore, and in a final evaluation more weight was generally given to the most recent data.

7 Applicability of SPERCs

7.1 Tiered assessment

SPERCs are intended to be more specific and accurate than ERCs. A discussion on the role of SPERCS in risk assessment can be found in Reihlen et al. (2016).

We consider SPERCs presented in that document to be suitable for use in standardized, lower tier REACH assessments for most formulation processes and the associated chemical ingredients. These SPERCs are conceived to allow risk assessors to discriminate substances with minor impact and emission situations from more challenging ones based on standardized emission estimates. "Based on this distinction, efforts can be focused on further (higher tier) assessments and refinement of problematic issues" (FEICA, 2016).

7.2 Regional assessment

In view that there is only limited variation in today's formulation processes of household care and professional cleaning and hygiene products across Europe, these SPERCs may be seen as broadly applicable.

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9 Annexes

9.1 Annex 1: Derivation of the M_{SPERC}'s

M_{SPERC} can be used by the registrant when starting the environmental assessment. M_{SPERC} represents an indicative worst-case value for the substance use rate per site. M_{SPERC} is calculated according to:

$$M_{SPERC} = M_{Finished} \times C_{SP} \times T_{Emission,SPERC}^{-1}$$

Where:

- C_{SP} = Exemplary concentration of substance in finished product (cleanright.eu, 2020)
- $M_{Finished}$ = the amount of finished product manufactured (per year),
- $T_{Emission,SPERC}$ = number of days emitting.

Typical parameters values are given in Annex 2. $M_{Finished}$ ranges correspond to the tonnage ranges of finished product as defined in Annex 2. The $M_{Finished}$ ranges are to help formulators find out which SPERC is relevant for their operation. For the large volume plants an arbitrary value of 250,000 tonnes per year has been chosen for the calculation.

9.2 Annex 2: Derivation of typical M_{SPERC}'s values.

Derivation of the default substance use rate M_{SPERC} for Industrial use in formulation of liquid cleaning and maintenance products. The derivation is based on typical values of the operational conditions for the various applications covered by this SPERC. The Csp values that are referenced in the below table are adjusted to reflect composition of representative product forms accounting for more than 80% of each product category.

Table 4: Tabulated values for derivation of typical M_{SPERC}'s.

Product characteristic	Substance's function	Range (1)	Indicative C_{SP} values	$M_{Finished}$ (tonnes/year)			$T_{emission}$ (days)			M_{SPERC} (tonnes/day)		
				small production	medium production	Large production (3)	small production (4)	medium production (5)	Large production (5)	small production	medium production	Large production
Regular granular and tableted products	Abrasive	0 - 97	97	(2)								
	Alkalinity sources	15 - 30	30.0	1 000	10 000	250 000	150	300	300	2.00	10.00	250.00
	Bleach Precursors	1 - 5	5.0	1 000	10 000	250 000	150	300	300	0.33	1.67	41.67
	Builders	1 - 30	30.0	1 000	10 000	250 000	150	300	300	2.00	10.00	250.00
	Enzymes	0 - 1	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Fragrances	0 - 1	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Optical Brighteners	0 - 0.5	0.2	1 000	10 000	250 000	150	300	300	0.01	0.07	1.67
	Oxidising Agents	3 - 30	10.0	1 000	10 000	250 000	150	300	300	0.67	3.33	83.33
	Sequestrants	0.2 - 1	1.0	1 000	10 000	250 000	150	300	300	0.07	0.33	8.33
	Surfactants	1 - 15	10.0	1 000	10 000	250 000	150	300	300	0.67	3.33	83.33
Liquid products of low viscosity	Abrasive	0 - 10	10	(2)								
	Alkalinity sources	0 - 10	5	1 000	10 000	250 000	150	300	300	0.33	1.67	41.67
	Builders	0 - 15	10	1 000	10 000	250 000	150	300	300	0.67	3.33	83.33
	Chelants	0 - 0.2	0.1	1 000	10 000	250 000	150	300	300	0.01	0.03	0.83
	Colour agents/dyes	0 - 1	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Enzymes	0 - 1	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Fragrances	0 - 5	2	1 000	10 000	250 000	150	300	300	0.13	0.67	16.67
	Hydrotropes	0 - 1	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Opacifier	0.1 - 0.5	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Optical Brighteners	0 - 1	0.2	1 000	10 000	250 000	150	300	300	0.01	0.07	1.67
	Oxidising Agents	0 - 5	1	1 000	10 000	250 000	150	300	300	0.07	0.33	8.33
	Polymers	0 - 5	2	1 000	10 000	250 000	150	300	300	0.13	0.67	16.67
	Preservatives	0 - 1.5	1	1 000	10 000	250 000	150	300	300	0.07	0.33	8.33
	Sequestrants	0 - 0.5	0.5	1 000	10 000	250 000	150	300	300	0.03	0.17	4.17
	Solvents	0 - 50	10	1 000	10 000	250 000	150	300	300	0.67	3.33	83.33
	Surfactants	0 - 30	20	1 000	10 000	250 000	150	300	300	1.33	6.67	166.67
	Viscosity Control	0 - 4	2	1 000	10 000	250 000	150	300	300	0.13	0.67	16.67
Liquid products: high viscosity	Colour agent	0 - 3	3	1 000	10 000	250 000	150	300	300	0.20	1.00	25.00
	Fragrances	0 - 10	5	1 000	10 000	250 000	150	300	300	0.33	1.67	41.67
	Preservatives	0 - 1	1	1 000	10 000	250 000	150	300	300	0.07	0.33	8.33
	Surfactants	0 - 30	20	1 000	10 000	250 000	150	300	300	1.33	6.67	166.67
	Waxes / parafines	0 - 40	5	1 000	10 000	250 000	150	300	300	0.33	1.67	41.67
Solid home and cosmetic products	Colourants	0 - 2	1	100 (6)	1 000	25 000	150	300	300	0.01	0.03	0.83
	Fragrances	0 - 2	1	100	1 000	25 000	150	300	300	0.01	0.03	0.83
	Surfactants	0 - 80	60	100	1 000	25 000	150	300	300	0.40	2.00	50.00
	Waxes & Paraffines (candle making)	0 - 100	30 (7)	100	1 000	25 000	150	300	300	0.20	1.00	25.00

(1) Source: standard product composition information found on cleanright.eu (2020) https://cleanright.eu/en/component/attachments/?task=download&id=33:A]
(2) Abrasive ingredients are almost exclusively used in scouring powders or creams. When used in this context, they can represent a very high percentage of product's composition. Since scouring powders and creams account only for a small fraction of their respective product categories, it is difficult to estimate typical M_{SPERC} values for these ingredients.
(3) 250 000 mT per year is a realistic annual production's tonnage for a large plant
(4) Source: Technical Guidance Document on risk assessment (2003). Calculated from table B2.4 for non-HPVC - page 249
(5) Source: Technical Guidance Document on risk assessment (2003). From table B2.5 for HPVC page 249
(6) Production scales of detergents are 10-fold higher than the production of solid cosmetic and home care products → see Ch. 5.1

(7) According to the production of soap and organic surface-active products was equal to 2,4 x 10 [6] in the EU. Hence, we estimate the production of candles to be at least 3 times smaller than the production of bar soaps.

10 Annex 3: Derivation of production scale estimation for detergent products

This Annex provides a detailed justification for the derivation of production scales from generic figures.

The A.I.S.E. Activity & Sustainability report (A.I.S.E, 2019) comprises circa 85% of total EU production for both the homecare and professional sectors that amounts to 11.3 million tonnes in 2019. Based on that fact, the total production for the sector is estimated to be equal to 13.3 million tonnes annually.

To obtain representative production volumes for household and professional cleaning and hygiene products, the A.I.S.E. data is coupled to the conservative assumption that large companies solely own large manufacturing sites. This is a conservative calculation as large sites will produce so much more than the smaller sites, they influence more heavily on the total volume. This approach enables the use of the following equation describing the total annual production of detergent in the EU:

13,300,000 = (105 × average production of large sites) + (595 × average production of small and medium sites)

Based on this equation, A.I.S.E. derived average plant's total production values for large and for small to medium sites. For a small/medium manufacturing site, average plant's total production was set at 10,000 ton/a. Hence, the average plant's total production for a large manufacturing site was set at 70,000 ton/a (starting from the left, see 1st green column of table 3).

Average plant's total productions have been set to values that are matching the total annual production of detergent in the EU. As shown in the below examples, the choice of alternative average production values for small/medium sites would have caused to significantly exceed the total EU detergent production of 13.3 million tonnes for the year 2019 or on the opposite, to not be able to meet it.

Table 5: Examples of alternative average production values for small/medium site, and the comparison to the total EU detergent production of 13.3 million tonnes for 2019

Choice of production values for large sites (ton/a)	Choice of production values for small to medium sites (ton/a)	Resulting equation	Resulting annual production of detergent in the EU (ton/a)	Validity check
70,000	10,000	(105 × 70,000 ton/a) + (595 × 10,000 ton/a)	13,300,000	☑
70,000	15,000	(105 × 70,000 ton/a) + (595 × 15,000 ton/a)	16,275,000 > 13,300,000	☒
60,000	15,000	(105 × 60,000 ton/a) + (595 × 15,000 ton/a)	15,225,000 > 13,300,000	☒
80,000	5,000	(105 × 80,000 ton/a) + (595 × 5,000 ton/a)	11,375,000 < 13,300,000	☒

The average plant's total production values that were derived from A.I.S.E. 2019 data, enabled the determination of the following cutoff values for total plant's production values through expert input (starting from the left, see 2nd green column of table 3):

- large scale site → > 30.000 tonnes total product per year,
- medium scale site → 5.000 - 30.000 tonnes total product per year,

- small scale site → < 5.000 tonnes total product per year.

Companies produce different product categories, comprising of more than just one production line. In that context, the most relevant approach when attempting to characterize the production scale of a given product category is to leverage data at a resolution that is as high as the production line itself. Considering the above production values per site, cutoff values for individual product lines' production have been introduced through expert input:

- large scale production line → > 10,000 tonnes product per category per year,
- medium scale production line → 1,000 - 10,000 tonnes product per category per year,
- small scale production line → <1,000 tonnes productper category per year.

The size of individual production line tonnage is the most relevant reflecting the SPERC's set-up.

Table 6: Table summarizing the definition of large/medium/small company, versus considerations on manufacturing tonnages relevant for the SPERCs.

	Definition of large/ medium or small company (Ref EU/2003/361)		**Definition of tonnage bands for large/ medium/ small production scale**		
Production Scale	Staff headcount	Turnover OR Balance sheet total	Average plant's total production (derived from A.I.S.E. 2019 data)	Cutoff values for total plant's production	Cutoff value for individual product lines' production = **SPERC category**
Large	>250	≥ € 50 m (turnover) ≥ € 43 m (balance)	70.000 ton/a	> 30.000 ton/a	**> 10.000 ton/a**
Medium	<250	≤ € 50 m (turnover) ≤ € 43 m (balance)	10.000 ton/a	5.000 ton/a to 30.000 ton/a	**1000 to 10.000 ton/a**
Small	<50	≤ € 10 m	n.a.	< 5.000 ton/a	**< 1000 ton/a**