Specific Environmental Release Categories (SPERCs) for the formulation of adhesives, sealants and construction chemical products

Background Document

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FEICA, the Association of the European Adhesive & Sealant Industry

Avenue E. van Nieuwenhuyse 2
B-1160 Brussels, Belgium
www.feica.eu

EFCC, the European Federation for Construction Chemicals

Avenue E. Van Nieuwenhuyse 6
B-1160 Brussels, Belgium
www.efcc.eu

Content

1 Statement of purpose

SPERCs are specific environmental release categories, and are meant to specify broad emission scenario information (ERCs) for the use of substances throughout their life cycle (Reihlen et al., 2016). The SPERCs described in this document are specific to the formulation of adhesives, sealants, and construction chemical products. Yet, they still reflect emission estimates of broadly defined formulation processes. This applies for processes which are operated according to common good practices. The SPERCs for the formulation of the mentioned products refine the single set of generic release factors for the *formulation of preparations* provided in the ECHA Guidance R16.

This document provides the background information to the SPERC factsheets for the formulation of solvent-borne and solvent-less adhesives/sealants and construction chemical products, as well as for water-borne adhesives and sealants, referring to ERC 2. In addition, a range of construction chemical products (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles) are produced in the same formulation processes as solvent and solvent-less adhesives and sealants. Thus, for these products, 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:

FEICA SPERC Code	**Type of ingredient**	**Product characteristic**	**Production Scale (products)**
FEICA / EFCC SPERC 2.1a.v3	non- volatile ingredients	Formulation of Solvent-borne and Solvent-less Adhesives / Sealants and Construction Chemical Products	All
FEICA / EFCC SPERC 2.1b.v3	volatile ingredients		Large Scale, > 1500 t/a
FEICA /EFCC SPERC 2.1c.v3	volatile ingredients		Small Scale, < 1500 t/a
FEICA / EFCC SPERC 2.2a.v3	volatile ingredients	Formulation of Water-borne Adhesives / Sealants and Construction Chemical Products	All
FEICA /EFCC SPERC 2.2b.v3	non- volatile ingredients		
FEICA / EFCC SPERC 2.3a.v1	non- volatile ingredients	Formulation of Cementitious Construction Chemical Products and Tile Adhesives	All

This background document provides information on the derivation of the relevant parameters of the above-mentioned factsheets. Some details refer to tertiary references, e.g. publications listed in chapter 8 and 9. As outlined below, the SPERCs described in this document are conservative for use in lower tier REACH safety assessments. 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

- **Adhesives and sealants** are products used to join and/or seal two or more substrates. Adhesives are used in bonding, facilitating the production of materials which are lightweight and/or flexible and which are used as components in aircraft and automobiles, in cell-phones, and in packaging materials. In addition, adhesives are used in the assembly of many products such as furniture, electronic devices, cars, etc.

Sealants allow the infilling of gaps between two or more substrates. They fulfil an important function in building and construction. Today, they are an essential element of modern engineering including, for instance, the automotive and aerospace industries.

Around 3,500,000 tonnes of adhesives and sealants are produced and used in Europe every year, for very diverse applications, most of which represents customised products (Tolls *et al.* 2015).

- **Construction chemical products** and tile adhesives are mixtures used or applied by professional workers on the construction sites and/or do-it-yourself home applications. These products cover concrete and mortar admixtures, as well as cement and gypsum for building and repairing construction works. They include hydrophobing agents, modified bitumen-based emulsions and liquid applied membranes - e.g. to seal, preserve and/or waterproof the construction surfaces. In addition, construction chemical products also include reactive resins applied in injection, bonding and anchoring construction pieces, as well as flooring resins for park decks and industrial applications.

For the construction chemical products, there is no data available in the literature on the volumes produced in Europe. Therefore, to have European estimates on such volumes, the European Federation for Construction Chemicals (EFCC) has conducted an internal survey among their member companies and the results were extrapolated to the entire market. Based on this calculation, it is estimated that around 7,000,000 tonnes of construction chemical products were produced and used in Europe in 2016 for very diverse applications (cf. Annex 5), most of which represent products for wide dispersive use.

The SPERCs of the two sector's applications are applied for refining the emissions of substances used in the formulation of Water- or Solvent-borne and Solvent-less Adhesives / Sealants and Construction Chemical Products. Volatile and non-volatile ingredients are distinguished by the boiling point threshold of 250°C, according to the definition of volatile organic compounds given by the World Health Organization (WHO, 1989). Formulation operations of adhesives, sealants and construction chemical products are assumed for 300 working/emission days per year. This figure is a reasonable assumption accounting for maintenance and holidays.

2.1.1 Adhesives and Sealants: ingredients and product types

The major constituents of adhesives and sealants (likewise for construction chemical products) are binders, fillers, and solvents. In addition, minor ingredients include additives such as catalysts and preservatives. Binders are typically natural or synthetic high molecular weight polymers. They may alternatively contain reactive organic compounds (e.g. prepolymers, oligomers, monomers) that form polymers during the bonding process. Details on ingredients and different product-types can be found in Table 1 and 2 (Tolls *et al.* 2015).

Besides the differentiation among their ingredient classes, to obtain adequate emission estimates, the following three product-types can be distinguished:

(1) Water-borne adhesives/sealants

(2a) Basically Water-free adhesives/sealants and

(2b) Solvent-borne adhesives/sealants

The latter group is comprised of (2a) Solvent-less adhesives/sealants (e.g. hotmelts) and (2b) Solvent-borne adhesives (e.g. acrylates, epoxies, urethanes and silicones). These two have in common the fact that water is not used during the cleaning of the equipment for the manufacture and application processes. Consequently, there are no emissions to water resulting from the cleaning, hence, for the

purpose of the emission estimation (in the SPERCs) these product-types are jointly referred to as solvent-borne/solvent-less adhesives/sealants.

Pressure sensitive adhesive formulations can be considered as hybrids, because they are initially formulated as a water- or organic solvent-based solution, and then applied to a substrate (e.g. tapes, labels) where the solvent is removed by evaporation before being sold as a component of various industrial and consumer products. These formulations can therefore either be described by product-types (1) or (2).

The analysis of the data for adhesives and sealants - resulting from the survey conducted by the Association of the European Adhesive and Sealant Industry (FEICA) - are detailed in Tables 2 and 3 (details can be found in Tolls *et al*. 2015).

Table 1: Poll results and expert evaluation in % for solvent-borne / solvent-less adhesives/sealants

Ingredient type	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Consensus Range**	**Indicative Value**
Solvent / Volatile	40 – 90	40 – 90	40 – 90	40-90	40-90	80
Binders/Fillers: Inorganic or polymeric*	20 – 40	20 – 40	20 – 60	20-60	20-60	50
Reactive Resins*	20 – 60	20 – 60	20 – 60	25-50	20-60	50
Fillers: Non-polymeric **	5 – 20	5 – 20	5 – 20	5 – 30	5 – 30	25
Pigments***	< 0.5	< 0.5	<5	< 0.5 - 1.0	<1	1
Catalysts	< 0.5	< 0.5	< 1	< 0.5	<1	1

Table 2: Poll results and expert evaluation in % for water-borne adhesives/sealants.

Ingredient type	**Expert 1**	**Expert 2**	**Expert 3**	**Expert 4**	**Consensus Range**	**Indicative Value**
Water	20-40	20-40	20-40	20 – 60	20-60	30
Solvent / Volatile / Emulsifier	5 – 10	5 - 10	5 - 10	5 – 10	5 – 10	10
Binders/Fillers: Inorganic or polymeric*	20 – 40	20 – 40	20 – ~~40~~ 60	20 – 40	20-60	50
Reactive Resins*	20 – 40	20 – 40	20 – 40	20 – 60	20-50	40
Fillers: Organic, non-polymeric **	5 – 10	5 – 10	5 – 10	5 – 10	5 – 10	10
Pigments ***	< 0.5	< 0.5	< 4	< 0.5 – 1.0	<1	1
Catalysts	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5
Preservatives	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.3

* This may include materials that are polymers according to the REACH definition. They are included in order to be comprehensive.

** This may include plasticizers and flame retardants and possibly other organic substances.

*** Pigments should only include such substances that are added to provide color. Titanium dioxide, iron oxide and carbon black added at up to 5% also act as fillers.

2.1.2 Construction chemical products: ingredients and product types

Similar to Adhesives and Sealants Construction Chemical Products can be differentiated by their use and characteristics of solvents, i.e. water or organic solvents. These ingredients predominately determine the way they are produced, how the equipment is cleaned and subsequent releases to the environment are described. Based on their ingredients and product properties, however, two main categories Construction Chemical Products can be distinguished:

1. Products with reactive ingredients. These products are produced in a relatively small amount – approx. around 600,000 tons/y. Their major constituents are binders, fillers, and solvents. Their specific properties involve the reaction of the ingredients (e.g. acrylates, epoxides, etc.) and therefore minor ingredients also include additives such as catalysts and in water based products preservatives. The binders are typically natural or synthetic high molecular weight polymers reactive organic compounds (e.g. prepolymers, oligomers, monomers) that form polymers during the bonding process.

2. Products with non-reactive ingredients are produced in high quantities – approx. around 6,300,000 tons/y. The products are generally not classified as dangerous to the environment. After use, the products become inert relatively quickly.

   Products with non-reactive ingredients can be based on bitumen or polymer dispersions. Cementitious construction products are subsumed in this category as well. The latter also include tile adhesives and modified mineral mortars, concrete repair products, cementitious screeds, floor levelling compounds, grouts, waterproofing slurries and pre-products for clinker manufacturing or products building concrete during use.

The table 3 below summarizes the results of the poll conducted by EFCC in 2017 among the main producers of construction chemical products. It represents the percentages of the typical use ranges, for each of the main product categories. The indicative values for the uses showed in the table can be applied by the registrants as a conservative data, to initiate their environmental risk assessments. The corresponding use volumes are reported in Annex 4.

Table 3: Poll results and expert evaluation in % for construction chemical products

construction chemicals product category	Ingredient types	Concentration of ingredient type (%)	
		Typical range [a]	Indicative value [b]
Construction chemical products based on reactive epoxy resins (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Binder	10 - 80	35
	Hardener	5 - 80	20
	Filler	0 - 80	50
	Pigments	0 -15	7
	Diluents	0 - 15	9
	Additives	0 - 10	3
Construction chemical products based on reactive polyurethane resins (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Binder	5 - 80	30
	Hardener	8 - 50	30
	Filler	0 - 80	60
	Pigments	0 - 10	7
	Diluents	0 - 40	20
	Additives	0 - 5	2
Construction chemical products based on other reactive resins (e.g. products for surface protection of concrete, primers, bonding agents, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Binder	10-30	25
	Hardener	1-5	4
	Filler	0 - 70	50
	Pigments	0-5	4
	Diluents	0 - 10	7
	Additives	0 - 10	5
Cementitious products (e.g. Modified mineral mortars, concrete repair poducts, tile adhesives, cementitious screeds, floor levelling compounds, grouts, waterproofing slurries)	Cement	2 - 90	40
	inorganic binders	0 - 90	60
	Filler / aggregates	5 - 90	70
	Pigments	0 - 10	4
	Additives	0 -30	3
Construction chemical products based on polymerdispersions (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Polymerdispersion	5 - 100	40
	Filler	0 - 90	50
	Pigment	0 - 40	25
	Additives	0 - 15	7

Table 3 cont.

construction chemicals product category	Ingredient types	Concentration of ingredient type (%)	
		Typical range [a]	Indicative value [b]
Water-borne bituminous products (e.g. polymer-modified bituminous thick coatings)	Bitumenemulsion	30 - 90	60
	Filler	0 - 40	25
	EPS	0 - 5	2
	Polymerdispersion	0 - 30	20
	Additive	0 - 5	3
solvent-borne bituminous products	Bitumen	30 - 90	70
	Organic solvents	0 - 70	25
	Filler	0 - 50	25
	Additives	0 - 5	3
Concrete release agents	Oils	90 - 100	95
	Additives	0 - 10	8
Concrete Admixtures	active agent	5 - 50	40
	water	50 - 95	90

Footnote a: The range covers more than 98% of the products in the market (according to the total volume)
Footnote b: The indicative value covers more than 90% of the products in the market (according to the total volume)

2.2 Formulation technologies

Basically, during the manufacture of adhesives, sealants and construction chemical products, three technologies can be distinguished (OECD 2009a):

(1) Heated mixing and transfer is employed either for manufacturing hot-melt adhesives or melt-blend powder coatings. While most components are expected to remain non-volatile at elevated temperatures; a small amount may potentially volatilize and be released from the process, resulting in a potential air exposure.

(2) Unsealed mixing and transfer, with a potential exposure to the fugitive releases of volatile components. It is employed for water-borne adhesives and sealants, as well as for aqueous dispersion coatings and water-reducible coatings and colloidal dispersions (i.e. stable under ambient conditions).

(3) Sealed mixing and transfer occurs in closed vessels, with no direct contact to the workers. In most cases, the components are transferred directly to the mixing vessel using closed lines and pumps. This requires increased process control in order to prevent the evaporation of solvents and to warrant the quality of the product. Avoiding the ambient humidity, for example, may be relevant for the manufacture of reactive adhesives. It is assumed that the sealed system captures the volatile

components released during the mixing process, and vents them through a stack to air outside the facility. Sealed processes are predominately applied to reactive and/or solvent based adhesives.

(4) Cementitious construction products and tile adhesives are produced in a dry batch process, where the main raw materials are fed, usually pneumatically, into the mixer in a closed process from silos. Small amount additives can be preweighed and added manually into the mixer. The air leaving the mixer is filtered to retain any dust inside the mixer. From the mixer products are transferred into the feeding hopper of the bagging machine. During bagging small amounts of dust can be lost as waste.

3 Emission relevance of operational conditions

The formulation of adhesives and sealants, as for this background document, is described by eight main process steps with potential releases into the environment (OECD 2009a). 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 the operational process can be differentiated into material loading emissions, surface evaporation, filling losses and all kinds of miscellaneous cleaning operations.

Table 3 displays the process steps that potentially lead to emissions to the environment originating from the manufacture of adhesives/sealants. Main emissions to the air are expected to come from Volatile Organic Compounds (VOCs) such as solvents. VOCs may be emitted during loading operations, or if the contents of mixers or dispersers are exposed to the atmosphere. Ventilation of buildings and air extraction from manufacturing equipment results in the loss of solvents used in the coating formulation. Raw materials in powder form, like pigments and fillers, can be emitted as dusts or particulates. These types of emissions may occur during weighing operations, during loading of the pre-mixer when a lid is open, or from the chute through which ingredients are added. Air extraction systems with dust filters are implemented as good practice, which have scrubbing efficiencies of 99% or more.

Although equipment cleaning may be performed periodically throughout the year, the default daily or batch-wise cleaning is accounted for in the release factors as a conservative estimate. The water used in the manufacturing process of the coatings, remains in the coatings formulation. The only origin of releases to water are cleaning operations. In contrast, equipment cleaning is irrelevant for solvent-borne and solvent-less products with regard to emissions to the environment. The equipment is cleaned with solvent washings, which are collected and disposed of as chemical waste that is subsequently treated by third party industries. As a consequence, the emissions of volatiles to water are negligible and the corresponding release factors are zero. Very little emission of non-solvent ingredients is expected from cleaning processes involving the removal of dust deposited on the workshop floor. In the case of cementitious products equipment cleaning in is done solely by dry sweeping and reusing of wastes. Therefore, no emission to water must be assumed.

No direct exposure of soil is to be expected during normal manufacturing operations.

In total, only a very small fraction of the substance 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.

Table 4: Overview of the processing steps involved in industrial manufacturing of adhesives/sealants and construction chemical products, and their relevance with regard to the emission estimation and derivation of release factors.

Processing Step		**Solvent-borne / solvent-less adhesives / sealants and construction chemical products**			**Water-borne adhesives / sealants and construction chemical products**		**Cementitious construction chemical products**
		non-volatiles	volatiles		non-volatiles	Volatiles	non-volatiles
FEICA SPERC		FEICA / EFCC SPERC 2.1a.v3	FEICA / EFCC SPERC 2.1b.v3	FEICA / EFCC SPERC 2.1c.v3	FEICA /EFCC SPERC 2.2b.v3	FEICA / EFCC SPERC 2.2a.v3	FEICA / EFCC SPERC 2.3a.v1
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. Dust emissions during loading operations of solid raw materials. Good practice is the installation of air extraction systems with dust filters.					
b	Container 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 disposed of as waste – no emissions to the environment.					
d	Formulation/ mixing	Mostly heated or sealed mixing: Vented losses of volatile chemicals and dust losses to air during mixing operations. Dust emissions during loading operations of solid raw materials. Good practice is the installation of air extraction systems with dust filters. Primary process for emissions - **accounted for in release factor**.			Mostly unsealed mixing: Dust emissions during loading operations of solid raw materials. Good practice is the installation of air extraction systems with dust filters. Fugitive losses of volatile chemicals to air during mixing operations **accounted for in release factor**.		Mostly closed batch mixers with pneumatic transfer of raw materials. Losses to air prevented with dust filters. **Accounted for in release factor.**
e	Product quality sampling	Product sampling wastes disposed to water, incineration or landfill.					
f	Packaging and/or filling	The product containers may be filled from storage tanks by workers connecting transfer lines to tank cars, totes, or drums (industrial adhesives), or by large automated bottling systems (consumer or commercial adhesives loaded and sold in small quantities). Little transfer operation losses of volatile chemicals to air.					

Table 4: cont'

Processing Step		**Solvent-borne / solvent-less adhesives / sealants and construction chemical products**			**Water-borne adhesives / sealants and construction chemical products**		**Cementitious construction chemical products**
		non-volatiles	volatiles		non-volatiles	Volatiles	non-volatiles
FEICA SPERC		FEICA / EFCC SPERC 2.1a.v3	FEICA / EFCC SPERC 2.1b.v3	FEICA / EFCC SPERC 2.1c.v3	FEICA /EFCC SPERC 2.2b.v3	FEICA / EFCC SPERC 2.2a.v3	FEICA / EFCC SPERC 2.3a.v1
g	equipment cleaning	Equipment cleaning, incinera-tion, or landfill. **accounted for in release factor**.	Emissions predomi-nantly to air. - **accounted for in release factor**.	Emissions predomi-nantly to air. - **accounted for in release factor**.	Equipment cleaning with water emissions to water, incineratio n, or landfill. **accounted for in release factor**.	Emissions predomi-nantly to air. - **accounted for in release factor**.	Equipment does usually not require cleaning due to the dry nature of the ingredients.
		Cleaning with organic solvent – solvents collected and disposed of as waste – no emissions to environment.			Cleaning with water – emissions to water – Significant process step - **accounted for in release factor**.		Only dry cleaning - **accounted for in release factor**.
h	Disposal of off-spec products	Spills to the floor are incidental and rare, due to targeted application of adhesive of sealant to substrate. Emissions to environment are irrelevant, in comparison with other process steps. According to OECD 2009b, best available techniques (BAT) to avoid significant emissions are the use of dish- or cone-bottomed vessels –for thick coatings often fitted with scraper blades. Another BAT option is the use of pigging systems for the cleaning of pipework. Off-spec product is disposed of as solid waste or reworked – no emissions to the environment.					Spills are rare and of low quantity, they are sweeped and disposed. Off-spec products are re-used in products. **Accounted for in release factor.**

In comparison, the processing steps in the coating industry that has been read across to adhesives and sealants are reported to be: storage, pre-weigh, transfer of bulk materials, dispersion process, milling, finishing (make up, mixing, sampling, tinting, adjustment), product filling (transfer, filtration, filling), cleaning of vessels (fixed and mobile), disposal (OECD 2009b).

4 Application of risk reduction measures

Since the volatile components in organic solvent-based adhesives and sealants may evaporate or degrade/react when exposed to ambient conditions, it is expected that their formulation process is sealed and vented to the air outside of the facility. Emission reduction measures may be required to a significant part during formulation of such products, in order to comply with the VOC-regulation. Hence, it is assumed for large scale manufacturing of solvent-based and solvent-less adhesives and

sealants using volatile raw materials that abatement techniques are generally applied. These may include adsorption with carbon, thermal or catalytic incineration, condensation at low temperature and biological treatment with liquid media (waste gas treatment; OECD 2009b). The abatement techniques applied achieve efficiencies of 80% and higher. In the small-scaled SPERCs emission reduction is not accounted for.

Non-volatile raw materials in powder form may generate dust, especially where the material has not yet been formulated (transfer of raw materials and formulation). It is good practice that a significant part of the emitted dust is collected by air extraction systems and local exhaust ventilation systems with the remainder collected by industrial vacuum cleaners, scrubbers or washed off during wet cleaning of the workshop floors. These cleaning processes are considered in the respective emission rates to water and to waste). The emission rates to air is defined based on assuming the presence of dust filters (e.g. air bag dust filters) that retain solid raw material dusts by a scrubbing efficiency of 99% (OECD 2009b). Such dust filter systems are mandatory for the production of cementitious construction chemical products (BREF, 2013, cf. ch.9.1.3).

5 SPERC Information sources and justification

Two relevant Emission Scenario Documents (ESD) were published by the Organization for Economic Cooperation and Development (OECD) on adhesive manufacturing (OECD, 2009a) and on the industrial use of adhesives (OECD, 2015). These documents provide detailed descriptions of the manufacturing and industrial use processes for adhesives and sealants, but they do not contain release factors. Consequently, the OECD ESD on paints and coatings (OECD 2009b) was used as a source for the release factors. The derivation of the release factors for adhesives and sealants from these information sources is described in Tolls *et al.* (2015) (see also chapter 9).

A search of the open literature from 1999 to 2014 with the key words “estimation, emission, and chemical” did not yield references relevant to emissions of substances from manufacturing or using adhesives or sealants.

5.1 Justification of use rates

Data on formulation dimensions and emissions of substances from manufacturing of different **adhesives and sealants** is provided in the Emission Scenario Document on adhesive manufacturing (OECD 2009a). Overall data on rate of manufacturing is provided by Tolls *et al.* (2015), based on FEICA research data. The total yearly production of adhesive and sealant products in the EU was 1,720,000 tons in 2013. From the annual facility production rates of adhesives for over 600 sites it can be seen that average large scale daily production rate exceeds small scale daily production rates by a factor of 10 (OECD 2009a). Derived from this survey the default production rate for large scale production of a general adhesive formulation amounts to 50,000 kg/d and for small scale production to 5,000 kg/d, respectively, based on 300 production days per year. Based on the figure for small scale formulation the production volumes of large- and small- scale formulations are indicated in the titles of the FEICA/EFCC SPERCs 2.1c and 2.1b, respectively. Due to similarities of formulations, the production scales of sealants were seen analogous to the adhesive production.

To gather representative information on adhesives, sealants and construction chemical products compositions, FEICA and EFCC conducted a survey among their membership. The individual company members were asked to provide their estimates of typical ingredient concentrations, as well as daily consumptions in large application machines. The estimated indicative ingredient use rates for

adhesives and sealants, represents typical large- and small-scale formulation sites of adhesives and sealants; they are specified in Tolls *et al.* (2015) and presented in Annex 9.4.

For **construction chemical** products the conducted survey on concentrations of individual product ingredients is presented in Table 3 of this background document. The total production tonnage of construction chemical products has been derived from market information of the "Deutsche Bauchemie" for Germany (2016, internal communication) and has subsequently cautiously extrapolated by experts of EFCC to the EU market. This extrapolation has been used as a basis for large-scale production plants, while indicative use tonnages for small-scale formulation has been estimated to be 10% of large-scale by read across to production volumes of adhesive and sealants local site information. These data is presented in annex 9.5. As these data reflects the total tonnages produced in Europe, the fraction of the main source (default=1) can be further adjusted according to the B-tables of the TGD, where applicable.

The indicative ingredient use rates for the formulation of each of the product types covered in this background document are estimated in a conservative manner. These are obtained by multiplying the indicative ingredient concentrations with estimated rates of facility manufacturing of the respective product category and production size. Hence, it is assumed as a worst case that the site produces solely the one product category of interest. According to expert's opinion, the values of the indicative ingredient concentrations cover more than 90% of adhesive/sealant and construction chemical products. Similarly, the values of the rates of manufacturing or use cover more than 90% of the formulation sites and of the industrial use sites.

5.2 Justification of days emitting

The justification of the emission days is a reasonable worse case assumption of a large industrial site, operating at >300 days a year. The 300 days per year excludes holidays (Sundays) and days for maintenance where operations are stopped or limited.

5.3 Justification of release factors

The justification method applied for deriving the release factors is read across (Reihlen et al., 2016). For the adhesive and sealant industry, only default models are available that assume two percent of the batch size or capacity of the process remains in the equipment as residue that is released as equipment cleaning waste. In the SPERCs covered in this document a read across of the release factors is made based on the similarities in the chemical ingredients and in the formulation process of coatings and paints, for which explicit OECD scenarios exist (OECD 2009b). The release factors of the SPERC for adhesives/sealants and construction chemical products have been selected as worst-case values in the course of reading across from emission scenarios to SPERCs (see Annex 1).

The emission factors for the production of cementitious construction chemical products is taken as read across from the production of Cement (BREF, 2013). In general, cement and cementitious products production does not generate waste water effluents. Compared to cement production only the dry process is applied for cementitious construction chemical products. During these processes the use of water is avoided. In principle, no emissions to water occur. Production solid wastes only occur during the final packaging of the finished product in low amounts. The emission that occurs is to air in the form of dust (non-volatiles). For the reduction of dust during production of cementitious construction chemical products and tile adhesives, filter systems are applied (cf. ch 4).

The details of the justification and the read across for adhesives and sealants are provided in Tolls *et al*. (2015). Solvent borne / solvent less and water borne construction chemical products can be considered similar to adhesives and sealants. The release factors are tabulated in Table 5.

Table 5. Summary of release factors for the SPERCs for manufacturing of adhesives/sealants and construction chemical products.

Release factors	**Solvent-borne / solvent-less adhesives / sealants and construction chemical products**			**Water-borne adhesives / sealants and construction chemical products**		**Cementitious construction chemical products**
	non-volatiles	volatiles		non-volatiles	volatiles	non-volatiles
FEICA SPERC	FEICA / EFCC SPERC 2.1a.v3	FEICA / EFCC SPERC 2.1b.v3	FEICA / EFCC SPERC 2.1c.v3	FEICA /EFCC SPERC 2.2b.v3	FEICA / EFCC SPERC 2.2a.v3	FEICA / EFCC SPERC 2.3a.v1
To air	0.08%	0.36%	3.6%	0.0097%	2.25%	0.005%
To water	0.02%	0%	0%	0.505%	0.5%	0%
To soil	0%	0%	0%	0%	0%	0%
To waste	0.2 -3%	0.2 -3%	0.2 -3%	0.2 -3%	0.2 -3%	0-1%

Except for the implementation of air extraction in large scale production and for cementitious construction chemical products, Risk Management Measures (RMMs) are not considered in the derivation of release factors. Hence, the SPERC release factors do not account for the possible effect of for example VOC emission reduction that may be a regulatory requirement under the VOC directive, and thus represent conservative estimates. As outlined in Tolls *et al.* (2015) the environmental release factors from the formulation process can be considered to be conservative and to overestimate the actual fractions emitted during adhesive/sealant manufacturing and use.

The amount of waste is mainly due to components remaining in transportation containers that depends on the size of the transport container and the physical form of the component. The waste fraction (0.2-3% for solids and volatiles) were obtained as worst case values from Container Release Models of the OECD ESD on adhesive formulation (OECD 2009a). For cementitious products some waste is produced during the filling process. Hence, a read across was made to waste production of solid compounds during the manufacturing of adhesive and sealants (<1%). The compilation of the data for waste and the derivation of the worst-case values is detailed Annex 2.

The waste fraction of cementitious products is read across to cement manufacturing. During the latter process $6.2x10^{-6}$ - $5.3x10^{-3}$ % of the raw materials are reported as loss via air emissions in the form of dust (BREF, 2013). The formulation of cementitious products often includes also ingredients with larger particle sizes as cement. Hence, a worst case dust emission to air of 0.005% is assumed.

Based on the figures for the release factors, indicative overall mass fluxes are provided for each SPERC in Annex 3.

5.4 Justification of Risk Management Measures

The implementation of RMMs to reduce dust emissions during manufacturing, as outlined in ch. 4, is mainly driven by the generic safety considerations of dust reduction for health and explosion hazards and to reach respective –mostly national- limits (e.g. OEL's, LEL's, dust explosion standards, etc.). Apart from that, no specific data were found on typical pollution control technologies used by the

adhesive formulation industry, although it is likely that some sites may implement pretreatment of their process wastewaters or have controls on their process stacks. However, these measures are not obligatory when industrial water emissions occur indirectly through municipal waste water treatment plants. The latter is set as a default.

Air extraction systems with dust filters are implemented as good practice, for cementitious products which have scrubbing efficiencies of 99%.

6 Conservatism

The conservatism in the emission estimation of the SPERCs for the manufacturing of adhesives/sealants and construction chemical products is warranted by assuming worst cases in both, the use rates and the release factors.

The substance use rates are indicative and may be iterated once applied. However, as they are based on average facility use rates they indicate a worst case production rate when applied to single product categories. The conservatism in the use rates is detailed in section 5.1.

The conservatism in the release rates is rooted in two causes: First, the worst-case values of release factors reported for different related processes have been selected in the read-across process (Tolls *et al.*, 2015, further information on the selection of worst case release factors is provided in Annex 1 and 2). Second, the read-across uses historic data from the OECD ESD on coatings and paints (OECD 2009b). This OECD ESD is based on two reference documents from 2000 and 2002. The latest information, which was included in the derivation of the release factors dates from 2003. Hence, the release factors used in the SPERCs for the formulation of adhesives and sealants reflect technology that is more than ten years old. Given the need for continuous efficiency gains in industrial processes and the concurrent technological advancement, it is fair to assume that adhesive and sealant application processes have become more efficient. This implies that the fractions of adhesives and sealants, that are released to air, water, and waste, have decreased. In conclusion, this also contributes to the conservatism of the emission estimation of the SPERCs for the manufacturing of adhesives/sealants and construction chemical products.

7 Applicability of SPERCs

7.1 Tiered assessment

Due to the characteristics described above, we consider the adhesives/sealants and construction chemical products SPERCs to be suitable for use in standardised, lower tier REACH assessments of the vast majority of their ingredient substances. Their envisaged use is for risk assessors to distinguish trivial substances and emission situations from problematic ones based on standardized emission estimates. Based on this distinction, efforts can be focused on further (higher tier) assessments and refinement of problematic issues.

7.2 Regional assessment

In view that that there is very limited regional variation in the formulation of adhesives/sealants and construction chemical products, SPERCs may be applicable for emission estimation of the industrial

use of adhesives / sealants and construction chemical products not only in the EU but also in other regions.

8 References

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9 Annexes

Annex 1 – Derivation of release factors for industrial formulation of adhesives and sealants.

9.1.1 Summary of the release factors for the manufacturing of water-borne coatings compiled from the OECD ESD (OECD 2009b). The values in bold specify the worst-case values that are used for the FEICA/EFCC SPERC - Table S1 of Tolls *et al.* (2015) publication

Overview of release factors for volatiles and non-volatiles from industrial coating manufacturing in OECD (OECD 2009b) on pages 75, 77, 82 and 84 respectively. The values in bold specify the worst-case values that are used for the FEICA SPERC.

		Release factor in % to		
	Batch size	**Air**	**Water**	**Soil**
Volatiles – aqueous dispersion coatings	Large	0.03-1.13	0	0
Volatiles – aqueous dispersion coatings	Small	0.06-2.25	0	0
Volatiles – water-reducible coatings and colloidal dispersions	Large	0.03-1.13	0.25	0
Volatiles – water-reducible coatings and colloidal dispersions	Small	0.06-2.25	0.5	0
Volatiles – water-borne, worst-case		**2.25**	**0.5**	**0**
Non-volatiles – aqueous dispersion coatings	Large	0.0097	0.253	0
Non-volatiles – aqueous dispersion coatings	Small	0.0095	0.505	0
Non-volatiles – water-reducible coatings and colloidal dispersions	Small	0.005	0.505	0
Non-volatiles – water-reducible coatings and colloidal dispersions	Large	0.0097	0.253	0
Non-volatiles – worst-case		**0.0097**	**0.505**	**0**

9.1.2 Summary of the release factors for the manufacturing of solvent-borne and solvent-less coatings compiled from the OECD ESD (OECD 2009b). The values in bold specify the worst-case values that are used for the FEICA/EFCC SPERC derivation of release factors

Overview of release factors for volatiles and non-volatiles from industrial coating manufacturing in OECD (OECD 2009b) on pages 56, 60, 63, 94, 100 and 107

		Release factor in % to		
	Batch Size	**Air**	**Water**	**Soil**
Volatiles: Type of Solvent - Low boiling point*	Small	0.766 - **3.6**	0	0
Volatiles: Type of Solvent - High boiling point*	Small	0.128 - 0.643	0	0
Volatiles: Type of Solvent - Low boiling point*	Large	0.07-**1.8 (0.36)****	0	0
Volatiles (worst Case)	Small	**3.6**	**0**	**0**
Volatiles (worst Case)	Large	**0.36**	**0**	**0**
Non-Volatiles (solvent borne coatings)	Small	0.0095	0.005	0
Non-Volatiles (solvent borne coatings)	Large	0.0097	0.003	0
Non-Volatiles (melt-blend powder coating)	Small	**0.08*****	0.52 **(0.02******)**	0
Non-Volatiles (melt-blend powder coating)	Large	0.03	0.26	0
Non-Volatiles (dry-blend powder coating)		0.014	0.26	0
Non-Volatiles (worst Case)		**0.08**	**0.02**	**0**

* Note that a low boiling point solvent would be up to ~ <110°C, while a high boiling point solvent would be ~ >110°C

** *The emission estimate of 0.36% takes 80% VOC removal into account representing good practice in large scale industry*

*** *this worst case estimate results from cumulative dust emissions during raw material transfer into pre-mixing vessel and flaking, crushing, transfer of the final product as well as air classification of coating particles*

*** citation from Tolls *et al.* 2015: *"According to the information in Table 3, the worst-case release factor to water for non-solvents in solvent-borne or solvent-free products should be 0.52%. According to the OECD ESD (OECD 2009b), it applies to solid melt-blend and to dry-blend powder coatings. It accounts for a contribution from the cleaning of equipment with water of 0.5%. Because this is irrelevant to the formulation of solvent-borne and solvent-free adhesives and sealants, this contribution is disregarded. Instead, the second contribution of approximately 0.02% of non-solvents ending up in wastewater is adopted as release factor to water for "Formulation of Solvent-free/Solvent-borne Adhesives— Non-solvents." It reflects the particular fraction of non-solvents that are emitted as dust during the loading of the mixing reactor, and settle on the floor, and are not removed by vacuum cleaning. For solvents, the release factors result from evaporation of solvents from the mixing reactor. The low value for the large-scale manufacturing reflects the assumption of an installation for removing solvents from the air."*

9.1.3 Summary of the release factors for the manufacturing of the formulation of cementitious products (non–volatiles) according to BREF (2013)

	Abatement technique	Release factor in % to			
		Air	Water	Soil	Waste
Cementitious products formulation (e.g. Modified mineral mortars, concrete repair poducts, tile adhesives, cementitious screeds, floor levelling compounds, grouts)	ESP*	0.002-0.005	0	0	0
	Fabric Filters	0.001-0.002	0	0	0
	Hybrid Filters	0.002-0.005	0	0	0
Cementitious products Filling line		0	0	0	1
Non-Volatiles in Cementitious Products (worst case)		**0.005**	**0**	**0**	**0-1**

* *ESP = electrostatic precipitators; may be used for their ability to operate under conditions of high temperatures (up to approximately 400°C) and high humidity.*

9.2 Annex 2

9.2.1 Release factors to waste for solid and liquid substances estimated for different steps during formulation of adhesives and sealants (OECD 2009a)

The release factors to waste for adhesives is derived as the maximum values of the sum of the container and equipment residues incl. filling lines. This value is 3% and the resulting range is reported as 0.2 – 3 % (ranges indicated in bold). These values are also representative for construction chemical products.

Chemical Form	**Vessel Type**	**V_{cont_empty} (gallons)**	**Model Title**	**$F_{container\ residue}$**	
Liquid substances	Bottle and small container	1-5 Range: <5- <20	*EPA/OPPT Small Container Residual Model*	Central Tendency: High End:	0.003 0.006
	Drum	55 Range: 20 to <100	*EPA/OPPT Drum Residual Model*	Central Tendency: High End: (for pumping liquid out of the drum)	0.025 **0.03**
				Central Tendency: High End: (for pouring liquid out of the drum)	0.003 0.006
	Tote	550 Range: 100 to <1,000	*EPA/OPPT Bulk Transport Residual Model*	Central Tendency: High End:	0.0007 **0.002**
	Tank Truck	5,000 Range: 1,000 to <10,000			
	Rail Car	20,000 Range: 10,000 and up			
Solid substances	Any	Any	*EPA/OPPT Solid Residuals in Transport Containers Model*		0.01
Mixture	Single Process Vessel		*EPA/OPPT Single Process Vessel Residual Model*	Conservative: (for pumping process materials from the vessel): Alternative defaults: Central Tendency: High End to Bounding: (alternative defaults for gravity-draining materials from the vessel)	0.01 0.0007 **0.002**
	Multiple Process Vessel		*EPA/OPPT Multiple Process Vessel Residual Model*		0.02
				Indicative worst case	**0.002 – 0.03**

9.3 Annex 3 – Overview of mass fluxes

9.3.1 Indicative mass fluxes for the SPERCs for formulation/manufacturing of adhesives and sealants and construction chemical products.

Direction of mass flux	**FEICA / EFCC SPERC 2.1a.v3**	**FEICA / EFCC SPERC 2.1b.v3**	**FEICA / EFCC SPERC 2.1c.v3**	**FEICA /EFCC SPERC 2.2b.v3**	**FEICA / EFCC SPERC 2.2a.v3**	**FEICA / EFCC SPERC 2.3a.v1**
	Solvent-borne / solvent-less adhesives / sealants and sealants and construction chemical products			Water-borne adhesives / sealants and construction chemical products		Formulation of cementitious construction chemical products and tile adhesives
	non-volatiles	volatiles		non-volatiles	volatiles	non-volatiles
	% of amount applied					
To product	>96.9%	>96.7%	>93.4%	>96.5%	>94.25%	>98.99%
To air	0.08%	0.36%	3.6%	0.0097%	2.25%	0.005%
To water	0.02%	0%	0%	0.505%	0.5%	0%
To soil	0%	0%	0%	0%	0%	0%
To waste	0.2 -3%	0.2 -3%	0.2 -3%	0.2 -3%	0.2 -3%	0-1%

9.4 Annex 4 – Indicative substance use rates of typical large-scale and small-scale formulation of adhesives and sealants according to its product categories (Tolls *et al.*, 2015)

Indicative rate of adhesive and sealant manufacturing (default)		**Large-scale formulation (50,000 kg/d)** [1]	**Small-scale formulation (5,000 kg/d)** [1]
Adhesive and sealant type	**Ingredient types**	**Indicative substance use rates (kg/d)** [2]	
Solvent-borne and solvent-less	Solvent, volatile	40,000	4,000
	Fillers, inorganic or polymeric[3]	25,000	2,500
	Reactive resins[3]	25,000	2,500
	Fillers: organic, non-polymeric[4]	12,500	1,250
	Pigments	<500	<50
	Catalysts	<500	<50
Water-borne	Water	not relevant	
	Solvent, volatile, emulsifier	5,000	500
	Fillers, inorganic or polymeric[3]	25,000	2,500
	Reactive resins[3]	20,000	2,000
	Fillers: organic, non-polymeric[4]	5,000	500
	Pigments[5]	<500	<50
	Catalysts	<250	<25
	Preservatives	<150	<15

1 note, that the indication of small- and large-scale production in the titles of FEICA/EFCC SPERCs 2.1c and 2.2b are based on the small scale production 5.000kg/d x 300 days = 1500t/a of products. Hence, the indication of largescale production being 50.000kg/d represents a realistic worst case calculation.
2 these substance use rates are derived by multiplying the indicative ingredient concentrations (see Table 3) with the default manufacturing rates of large- and small scale formulations
3 not relevant from REACH exposure assessment perspective, because exempt from REACH or not classified
4 These substances often fulfil multiple functions such as flame retardants, plasticizers, or fillers.
5 Addresses pigments used for providing color exclusively. Inorganic pigments such as titanium dioxide, iron oxide, and carbon black added up to 5% should be considered as filler

9.5 Annex 5 – Rate of construction chemical products manufacturing according to its product categories

9.5.1 Categories of construction chemical products and its main ingredient types and indicative substance use rates (M_{SPERC}) for small and large scale formulation (in t/y).

Construction Chemicals Product category	Ingredient types	Indicative use rate (M_{SPERC}) and manufactured tonnages of construction chemical products in Europe (estimates for 2016)			
		Small-scale formulation (tons/d)	Small-scale formulation (tons/y)	Large-scale formulation (tons/d)	Large-scale formulation (tons/y)
Construction chemical products based on reactive epoxy resins (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Overall	50	15,000	500	150,000
	Binder	18	5,300	180	53,000
	Hardener	10	3,000	100	30,000
	Filler	25	7,500	250	75,000
	Pigments	3.5	1,100	35	11,000
	Diluents	4.5	1,400	45	14,000
	Additives	1.5	450	15	4,500
Construction chemical products based on reactive polyurethane resins (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Overall	23	7,000	233	70,000
	Binder	7	2,100	70	21,000
	Hardener	7	2,100	70	21,000
	Filler	14	4,200	140	42,000
	Pigments	1.6	490	16	4,900
	Diluents	4.7	1,400	47	14,000
	Additives	0.5	140	5	1,400

Table 9.5.1 (cont.)

Construction Chemicals Product category	Ingredient types	Indicative use rate (M_{SPERC}) of production chemicals manufacturing in Europe			
		Small-scale formulation (tons/d)	Small-scale formulation (tons/y)	Large-scale formulation (tons/d)	Large-scale formulation (tons/y)
Construction chemical products based on other reactive resins (e.g. products for surface protection of concrete, primers, bonding agents, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Overall	15	4,500	150	45,000
	Binder	3.8	1,100	38	11,000
	Hardener	0.6	180	6	1,800
	Filler	7.5	2,300	75	23,000
	Pigments	0,6	180	6	1,800
	Diluents	1.1	320	11	3,200
	Additives	0,8	230	8	2,300
Cementitious products (e.g. Modified mineral mortars, concrete repair poducts, tile adhesives, cementitious screeds, floor levelling compounds, grouts, waterproofing slurries)	Overall	1,670	500,000	16,700	5,000,000
	Cement	670	200,000	6,700	2,000,000
	inorganic binders	1,000	300,000	10,000	3,000,000
	Filler / aggregates	1,200	350,000	12,000	3,500,000
	Pigments	67	20,000	670	200,000
	Additives	50	15,000	500	150,000
Construction chemical products based on polymerdispersions (e.g. products for surface protection of concrete, products for concrete injection, waterproofing, floor screeds, flooring, functional coatings, adhesives for tiles)	Overall	3.3	1,000	33	10,000
	Polymerdispersion	1.3	400	13	4,000
	Filler	1.7	500	17	5,000
	Pigment	0.8	250	8	2,500
	Additives	0.2	70	2	700

Table 9.5.1 (cont.)

Construction Chemicals Product category	Ingredient types	Indicative use rate (M_{SPERC}) of production chemical products manufacturing in Europe			
		Small-scale formulation (tons/d)	Small-scale formulation (tons/y)	Large-scale formulation (tons/d)	Large-scale formulation (tons/y)
Water-borne bituminous products (e.g. polymer-modified bituminous thick coatings)	Overall	100	30,000	1,000	300,000
	Bitumen Emulsion	60	18,000	600	180,000
	Filler	25	7,500	250	75,000
	EPS	2	600	20	6,000
	Polymerdispersion	20	6,000	200	60,000
	Additive	3	900	30	9,000
solvent-borne bituminous products	Overall	4.3	1,300	43	13,000
	Bitumen	3	910	30	9,100
	Organic solvents	1.1	330	11	3,300
	Filler	1.1	330	11	3,300
	Additives	1	39.8	1	390
-					
Concrete release agents	Overall	27.4	8,200	274	82,200
	Oils	26	7,800	260	78,000
	Additives	2.2	660	22	6,600
Concrete Admixtures	Overall	400	120,000	4,000	1,200,000
	active agent	160	48,000	1,600	480,000
	water	360	110,000	3,600	1,100,000