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MATRIX BETWEEN EMISSION SCENARIO DOCUMENTS (ESDS) AND SPECIFIC ENVIRONMENTAL RELEASE CATEGORIES (SPERCS)

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INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

A cooperative agreement among FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD

Environment Directorate
ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT
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Foreword

Over 30 Emission Scenario Documents (ESDs) have been published so far in the OECD Series on ESDs. ESDs aim to describe the sources, production processes, pathways and use patterns of chemicals and quantify their emissions from production, formulation, processing, professional and private use and recovery/disposal into water, air, soil and/or solid waste, and. ESDs are used in risk assessments of chemicals as the basis for estimating the release of chemicals to the environment. On the other hand, the European Industry Sector Associations (CEFIC, AISE, FEICA, Eurometaux, etc.) have developed Specific Environmental Release Categories (SpERCs), describing the typical operations in their sectors including release factors for chemicals and efficiencies of Risk Management Measures /Operation Conditions in reducing emissions of chemicals.

In 2013, the OECD's Working Party on Exposure Assessment (WPEA, formerly Task Force on Exposure Assessment) agreed to launch a project to develop a matrix on the availability and coverage of ESDs and SpERCs compared to the use descriptors listed in the "Crosswalk of harmonized U.S. - Canada Industrial Function and Consumer and Commercial Product Categories with EU Chemical Product and Article Categories", published in 2012 (ENV/JM/MONO(2012)5).

A subgroup, composed of France, Germany, the Netherlands, the United States, the European Union and led by Japan, was formed to scope and implement this project. The project report was produced mainly on the basis of a survey made by Mr. Yusuke Hirai and Mr. Masashi Horie of the National Institute of Technology and Evaluation (NITE) of Japan. This report was prepared under the supervision of the WPEA, and the final draft of the document was approved by the WPEA in June 2018.

There was general consensus that a collaboration between authors of ESDs and SpERCs could generate synergies to improve the quality of data in both ESDs and SpERCs, reduce the burden of governments and industrial sectors, as well as help evolve the approach for developing and maintaining these documents. This project describes the coverage of ESDs and SpERCs and provides insight on differences and similarities between these documents. This project also provided insight on whether and how these documents could be better used, and whether and how the approaches for developing them could be improved.

This document can be used as a reference document for deciding on the strengths and weaknesses of ESDs and SpERCs. It provides information on what use categories and what life-cycle stages are covered by existing ESDs and/or SpERCs. Also, the document can help developers of ESDs or SpERCs to improve the transparency and quality of ESDs and SpERCs, and fill gaps (i.e. use categories and life-cycle stages) where no ESDs or SpERCs are available.

This report is published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology of the OECD.

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Abbreviations and acronyms

AC: Article Category
ACEA: European Automobile Manufacturers' Association
AIRC: Global Federation of National Trade Organizations in the Area of Vehicle Repairs
AISE: International Association for Soaps, Detergents and Maintenance Products
CEFIC: European Chemical Industry Council
CEPE: European Sector Group of the Producers and Users of Paints, Printing Inks, Industrial Coatings and Artists' Colours
COLIPA (Cosmetic Europe): European Trade Association of the Cosmetics Industry
ECCA: European Coil Coating Association
ECHA: European Chemicals Agency
ECPA: European Crop protection Association
EFCC: European Federation for Construction Chemicals
EMPAC: European Metal Packaging
EPA: Environmental Protection Agency
ERC: Environmental Release Category
ESDs: Emission Scenario Documents
ESIG: European Solvents Industry Group
ESVOC: European Solvents Downstream User Coordination Group
ETRMA: European Tyre & Rubber Manufactures' Association
Eurometaux: European Association of Metals
FEICA: Association of the European Adhesive & Sealant Industry
IR&CSA: Information Requirements & Chemical Safety Assessment
NITE: National Institute of Technology and Evaluation
PC: Product Category
PROC: Process Category
REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals
RIVM: Dutch National Institute for Public Health and the Environment
SpERCs: Specific Environmental Release Categories
SU: Sector of Use
TEGEWA: German Federation of the Textile Chemical Industry
UBA: German Federal Environment Agency

Executive Summary

There are no documents that explain the commonalities and differences between the OECD's Emission Scenario Documents (ESDs) and the EU's Specific Environmental Release Categories (SpERCs) nor that summarise which exposure assessment approaches are addressed by ESDs and SpERCs. This project proposes to fill this gap. This report identifies gaps in types of uses and life-cycle stages covered by ESDs or SpERCs and can be used to identify priorities for the development of additional ESDs or SpERCs.

The analysis focuses on the 26 ESDs and the 14 SpERCs published before the end of 2014. In addition, two sets of ESDs and SpERCs on Textile Finishing and on Adhesive Formulation, were selected for a comparative case study on the process flow and respective emission sources and factors.

As a result of the two case studies, the following similarities of ESDs and SpERCs were identified:

1. The main emission sources and routes as well as the environmental media (e.g. air, water) receiving the main emission are well identified; and
2. The key physical-chemical properties that mostly affect the emission factors are highlighted.

On the other hand, a number of quantitative and qualitative differences were identified:

1. The categories for life-cycle stages used in the guidance document for developing ESDs are slightly different from those used in the guidance documents for implementing the EU Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH);
2. The granularity of differentiating between processes (and the related chemicals and conditions of use) can be different between SpERCs and ESDs;
3. To estimate emissions, the model formulas often lack defined emission factors in the ESDs, while emission factors associated with the conditions of use are defined in the SpERCs; and
4. ESDs aim to provide emission estimations at each life-cycle stage, while it is not the purpose of a SpERC to provide direct emission estimations but to provide quantitative exposure parameter (e.g. release factors, etc.) for a specific application during a life cycle stage. Using these parameters, a risk assessor estimates the risk potential from the exposure caused by a distinct use.

To improve the comparability between ESDs and SpERCs, it is recommended that:

1. SpERCs could be improved on the following points;
    - For each SpERC a published background document should be available, describing the conditions of use driving the release and explaining how the release factors were derived;
    - SpERCs should be incorporated into use-maps so that it is traceable to which uses they refer and that they can be connected to the corresponding conditions of use from a worker and consumer perspective; and
    - The work processes used to determine release factors should be described and use descriptions should be related to work processes.
2. ESDs could be improved on the following points:
    - The life-cycle stage covered by the ESDs should be better defined (note that the ESD's guidance document requests that the ESDs include different life-cycle stages), especially regarding industrial use, professional use and private use;
    - Their background information and data should be updated based on a new analysis of best available techniques;
    - Background information should be provided to make it clear where the default is derived from when emission estimations are conducted by default model assumptions; and
    - New ESDs should be developed to fill gaps on use and life-cycle stages identified in this document.

1. Objectives

1.1. Background

Over 30 Emission Scenario Documents (ESDs) have been published in the OECD Series on ESDs. ESDs have been widely used in national and regional contexts. For example, the European Chemicals Agency (ECHA)'s guidance document on environmental exposure estimation refers to existing ESDs developed by the OECD and the European Commission. Also, the US EPA has developed a number of generic scenarios to be used as default release scenarios in risk assessment. Furthermore, Japan has referred to several ESDs in its national risk assessment guidance.

On the other hand, European Industry Sector Associations (European Chemical Industry Council (CEFIC), International Association for Soaps, Detergents and Maintenance Products (AISE), Association of the European Adhesive & Sealant Industry (FEICA), European Association of Metals (Eurometaux), etc.) have developed Specific Environmental Release Categories (SpERCs), describing the environmental emissions of chemicals during typical operations (Operation Conditions) in their sectors, including release factors and efficiencies of Risk Management Measure. These SpERCs can be used for Environmental Exposure Estimates applied for risk assessment purposes required under the EU Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH; Ahrens et al 2017, CEFIC,2012; Sättler et al., 2012; UBA, 2011).

SpERCs are different from ESDs in that ESDs consider the processes associated with specific chemical and formulated product industries, i.e. a cradle to grave analysis. SpERCs are a collection of boundary parameters that present a matrix for emissions to environmental media which are associated with the release or loss of a substance due to human activity, or a mechanical process.

1.2. Purpose of the project

ESDs and SpERCs are very useful tools to conduct exposure assessments. However, there are no documents that explain the commonalities and differences between ESDs and SpERCs nor that summarise which life-cycle stages and types of uses are covered by ESDs and SpERCs. This report was developed to fill this gap. It identifies gaps in types of uses and life-cycle stages covered by ESDs or SpERCs and can be used to identify priorities for the improvement of existing and the development of additional ESDs or SpERCs.

While ESDs consider the processes associated with specific chemical and formulated product industries, SpERCs are made for lower tier risk assessment purposes. Within a certain industry sector they represent a

collection of boundary parameters building a matrix for exposure estimates to environmental media which are associated with the releases or losses of a substance due to human activity, or a mechanical process. Information on emission factors in the SpERCs serves the exposure assessment of a defined scope/use. Depending on the purpose of the risk assessment, the scope can be more narrow or broad. This is reflected by the conservatism applied differently in each SpERC. SpERCs are specific for certain life cycle stages of a certain product category. This report aims to:

- outline differences of the scope (e.g. in the coverage of life-cycle stages) of ESDs and SpERCs;
- explain similarities and dissimilarities between ESDs and SpERCs;
- identify emission scenarios not covered by ESDs or SpERCs;
- identify emission scenarios necessary to be developed for exposure assessment; and
- outline differences of emission scenarios of ESDs or SpERCs to assist assessors in using ESDs or SpERCs appropriately according to their purpose.

The overview of existing ESDs and SpERCs (i.e. mapping of ESDs and SpERCs) will help identify gaps or differences between ESDs and SpERCs, and set priorities for the development of new ESDs or SpERCs. It also helps avoiding duplicative efforts by OECD countries and industry sectors.

1.3. ESDs by OECD

In 1998, the OECD's Task Force on Environmental Exposure Assessment launched a pilot project to investigate the feasibility of developing OECD-wide emission scenario documents. The conclusion from this pilot project was that the development of emission scenario documents at the OECD level would be possible and that wider acceptance of emission scenario documents would help to reduce duplicative efforts made by OECD countries and industry in the gathering of exposure information and improve the consistency and transparency of exposure assessments. Up until 2018, 37 ESDs led by OECD countries have been published.

The information in ESDs can be used in the estimation of concentrations of substances in the environment. Different types of estimated concentration are required by OECD countries, depending on the level and purpose of the assessment being carried out. The different types of estimated concentration are summarized as:

1. a value that likely exceeds actual exposures (a "bounding" or "worst-case" estimate);
2. a value that is representative of the "high end" of actual exposures (a "reasonable worst case" estimate, the 90th percentile is often used); and

3. a value that is representative of "typical" exposures, or the complete set of actual exposure values resulting from those conditions.

To date, the majority of ESDs have aimed to produce estimates of type (b), 'high end' or 'realistic worst case' concentrations (ENV/JM/MONO(2008)41/REV1).

1.4. SpERCs by EU

Chapter R16 of the REACH Guidance on Information Requirements & Chemical Safety Assessment (IR&CSA) identifies Environmental Release Categories (ERCs) as a set of use descriptors that would generate conservative release estimation from a specific use of a substance correlating to general stages of the life cycle of that substance. An industry evaluation concluded that although ERCs help achieve standardization, they lead to unrealistically conservative emission estimates. The IR&CSA guidance acknowledged that an "ERC should be used as a starting point for emission estimation" and explicitly encouraged the use of more refined or specific information for emissions. CEFIC Guidance on Specific Environmental Release Categories (SpERCs) was developed to provide guidance on the development, and use of SpERCs, which are described as follows:

- SpERCs usually refine the very generic ERC-based emission estimation;
- SpERCs describe typical operational conditions that are relevant with regard to the emissions of substances to the environment; and
- SpERCs define realistic default values of the fractions which are released to water, air, soil and, where appropriate, waste.

2. Analysis between ESDs and SpERCs

2.1. Approaches to compare ESDs and SpERCs

In order to compare ESDs with SpERCs, a common scale was defined.

"Life-cycle stage" was considered as a common scale for both the ESDs and the SpERCs since the guidance document on the ESDs [ENV/JM/MONO(2000)12] requests all ESDs to identify their life-cycle stages in the documents, and the SpERCs also apply life cycle stages as one of six elements that should be described. The report uses life-cycle stages as defined in the REACH guidance documents (ECHA, 2015). Note that there are slight differences in the life-cycle stages between the REACH guidance document and the ESDs guidance document. According to the REACH Guidance document, the life-cycle stages are Manufacturing, Formulation, End-use (Use at industrial sites, Widespread use by professional workers and Consumer Use), Service Life and Waste Disposal, while the ESDs guidance document defines Production, Formulation, Processing, Private Use (or use in household), Recovery/Disposal and Service Life ([ENV/JM/MONO(2000)12 and ENV/JM/MONO(2008)41/REV1]. According to the ESDs guidance document, ESDs do not seem to distinguish between "Professional Use" and "Private Use".Our analysis revealed that there are three ESDs covering "Professional Use", and no ESDs covering "Private Use" (see Table 1).

Table 1. The comparison of life-cycle stages between REACH and ESD

	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal
REACH	Manufacturing	Formulation	End-use			Service Life	Waste Disposal
			Use at industrial sites	Widespread use by professional workers	Consumer Use		
ESD	Production	Formulation	Processing	Private Use (or use in household)	Private Use (or use in household)[1]	Service Life	Recovery/ Disposal

The project also analysed the coverage of the ESDs by using REACH's Use Descriptors, namely Sector of Use (SU), Process Category (PROC), Product Category (PC), Article Category (AC), and ERCs.

This analysis relied on previous studies by UBA & RIVM (2006), Kubota et al. (2005), and the OECD document on the "Crosswalk of harmonized U.S. - Canada Industrial Function and Consumer and Commercial Product Categories with EU Chemical Product and Article Categories" published in 2012 [ENV/JM/MONO(2012)5].

[1] In our analysis, we didn't find ESD covering "Private use".

2.2. Selection of candidate ESDs

The project analysed 25 ESDs published before the end of 2014 (see Table 2 for the list of ESDs).

1. ESD No.1 and ESD No.19 are guidance documents and therefore were excluded.
2. ESDs No.2, No.13-14 and No.18 were excluded because these cover specific biocide use.

The project then analysed the life-cycle stages described in ESDs according to the REACH guidance categories. The result of mapping the ESD life-cycle stage is summarised in Table 2.

A similar mapping analysis was conducted for SpERCs. The result is summarized in Table 3.

By comparing Table 2 and Table 3, the life cycle coverage of ESDs and SpERCs for different industrial sectors is summarized in Table 8. The following ESDs were exempted from the detailed analysis:

1. ESDs No.5, No.9, No.15-17, No. 23, No.25-27, No.30 and No.32 as no SpERCs was developed in the similar sectors; and
2. ESDs No.3-4, No.6, No.8, No.10-12, No.21, No.22, No.24, No.28-29 and No.31 as these ESDs were covered by multiple SpERCs and/or life-cycle stages in the ESDs were not covered by the SpERC.

Table 2. Mapping the ESD Life-cycle Stage and Use Descriptor

ESD No	Title	Published year	Lead Country	Chemical Product Category (PC)	Article Category (AC)	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal[2]
31	Chemicals used in oil well production	2012	US	0	-	-[3]	-	○[4]	-	-	-	-
30	Chemical Industry	2011	Netherlands	0, 2, 16, 20, 27, 29	-	○	○	○	-	-	○	-
29	Water Based Washing Operations at Industrial and Institutional Laundries	2011	US	35	-	-	-	○	○	-	-	-
28	Metalworking Fluids	2011	US	25	-	-	-	○	-	-	-	-
27	Radiation Curable Coating, Inks and Adhesives	2011	US	1,9a,18	-	-	-	○	-	-	-	-
26	Blending of Fragrance Oils into Commercial and Consumer Products	2010	US	3,28,35	0	-	○	-	-	-	-	-
25	Chemicals Used in the Electronics Industry	2010	UK	0,14,30,33,38	2	-	○	○	-	-	○	○
24	Transport and Storage of Chemicals	2009	UK	Any PC	-	○	○	○	-	-	○	○
23	Pulp, Paper and Board Industry	2009	US	26	8	-	-	○	-	-	-	-
22	Coating Industry (Paints, Lacquers and Varnishes)	2009	UK	9a,9b	1,7,11	-	○	○	-	-	○	-
21	Formulation of Radiation Curable Coatings, Inks and Adhesives	2009	US	1,9a,18,19	-	-	○	-	-	-	-	-
20	Adhesive Formulation	2009	US	1	-	-	○	-	-	-	-	-
17	Recovered Paper Mills	2006	Canada	26	8	-	-	○	-	-	-	-
16	Non-Integrated Paper Mills	2006	Canada	26	8	-	-	○	-	-	-	-
15	Kraft Pulp Mills	2006	Canada	26	8	-	-	○	-	-	-	-
12	Metal finishing	2004	UK	14	7	-	-	○	○	-	-	-

Table 2. Mapping the ESD Life-cycle Stage and Use Descriptor

ESD No	Title	Published year	Lead Country	Chemical Product Category (PC)	Article Category (AC)	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal[2]
11	Automotive spray application	2004, revised in 2011	US	9a	1	-	-	○	○	-	-	-
10	Lubricants and Lubricant Additives	2004	UK	17,24,25	1	-	○	-	-	-	○	-
9	Photoresist Use in Semiconductor Manufacturing	2004, revised in 2010	US	33	2	-	-	○	-	-	-	-
8	Leather Processing	2004	Germany	23	6	-	-	○	-	-	-	-
7	Textile Finishing	2004	Germany and France	34	5	○	○	○	-	-	○	-
6	Rubber Additives	2004	Germany	32	10	-	-	○	-	-	○	-
5	Photographic Industry	2004	Germany	30	-	○	○	-	-	-	-	○
4	Water Treatment Chemicals	2004	UK	4,8,37	-	-	-	○	-	-	-	-
3	Plastic Additives	2004, revised in 2009	UK	32	13	-	○	-	-	-	○	○

[2] "Waste disposal" is identifying fraction releases once it is in the waste disposal stream.

[3] "-" means that the ESDs do not covered these life-cycle stages.

[4] "○" means that the ESDs cover these life-cycle stages.

Table 3. Mapping the SpERC Life-cycle Stage and Use Descriptor

No	SpERCs Developer	Sector	SpERCs guidance (2012)	Factsheet	Use mapping/ Library	Sector of Use (SU)	Chemical Product Category (PC)	Article Category (AC)	Environmental Release Category (ERC)	Produc-tion	Formu-lation	Industrial use	Profe-ssional use	Private use	Service life	Waste disposal[5]
1	ACEA	Automobile Manufacturers	○	20-Mar-13	-	6a, 11, 12, 13, 15, 16, 17, 18	9a,	-	4, 5	-	-	○	-	-	-	-
2	AIRC	vehicle repairs	○	-	-	-	-	-	4, 5	-	-	○	-	-	-	-
3	AISE	Detergents-soaps	○	Oct-12	-	-	3, 8, 14, 31, 35	-	2, 4, 5, 8a	-	○	○	○	○	-	-
4	CEPE	Coatings, Inks, Artist colours	○	2010	-	-	9a, 9b, 9c	-	2, 4, 5, 8a, 8c, 8d, 8f	-	○	○	○	○	-	-
5	Cosmetic Europe (COLIPA)	Cosmetics	○	Oct-12	15-Apr-10	-	39	-	2, 8a	-	○	-	○	○	-	-
6	ECCA	Coil Coatings	○	-	13-May-10	11, 12, 13, 15, 16, 17, 18, 19	-	0	4, 5	-	-	○	-	-	-	-
7	ECPA	Crop protection	○	Sep-13	-	1	27	-	8a, 8d	-	-	-	○	○	-	-
8	EFCC	Construction	○	Nov-10	Apr-10	-	1, 9a, 9b	4, 11, 13	2, 4, 5, 8a, 8c, 8d, 8f, 10a, 11a	-	○	○	○	○	○	-
9	EMPAC	Metal Packaging	○	-	-	-	-	-	4, 5	-	○	-	-	-	-	-
10	ESIG/ ESVOC	Solvents	○	-	2-Jul-10	8, 9	1, 3, 4, 8, 9, 13, 16, 17, 24, 31, 35, 36, 37, 38	-	1, 2, 3, 4, 5, 6, 7, 8a, 8d, 8e8f, 9a, 9b	○	○	○	○	-	-	-
11	ETRMA	Rubber	○	4-Aug-10	4-Aug-10	-	-	-	3, 4, 6d	-	○	○	-	-	-	-
12	Eurometaux	Metals	○	2013	-	14	-	-	1, 2, 3, 4, 5, 6a, 6b, 12a	○	○	○	-	-	-	-

Table 3. Mapping the SpERC Life-cycle Stage and Use Descriptor

No	SpERCs Developer	Sector	SpERCs guidance (2012)	Factsheet	Use mapping/ Library	Sector of Use (SU)	Chemical Product Category (PC)	Article Category (AC)	Environmental Release Category (ERC)	Produc-tion	Formu-lation	Industrial use	Profe-ssional use	Private use	Service life	Waste disposal[5]
13	FEICA	Adhesives and sealants	○	Feb-13	17-Jul-13	19	0, 1, 9a, 9b	-	2,4,5,8a,8c	-	○	○	○	○	-	-
14	TEGEWA	Processing of Textiles etc.	○	-	Nov-09	5	1, 8, 18, 20, 24, 32, 34, 35	1, 2, 4, 5, 7, 8, 10, 0	2, 3, 4, 5, 6b, 6d, 10a, 10b, 11a, 11b	-	○	○	-	-	○	-

[5] "Waste disposal" is identifying fraction releases once it is in the waste disposal stream.

Table 2. ECHA Descriptor list for Sectors of use (SU)

Code	Name
SU1	Agriculture, forestry, fishery
SU2a	Mining, (without offshore industries)
SU2b	Offshore industries
SU4	Manufacture of food products
SU5	Manufacture of textiles, leather, fur
SU6a	Manufacture of wood and wood products
SU6b	Manufacture of pulp, paper and paper products
SU7	Printing and reproduction of recorded media
SU8	Manufacture of bulk, large scale chemicals (including petroleum products)
SU9	Manufacture of fine chemicals
SU11	Manufacture of rubber products
SU12	Manufacture of plastics products, including compounding and conversion
SU13	Manufacture of other non-metallic mineral products, e.g. plasters, cement
SU14	Manufacture of basic metals, including alloys
SU15	Manufacture of fabricated metal products, except machinery and equipment
SU16	Manufacture of computer, electronic and optical products, electrical equipment
SU17	General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment
SU18	Manufacture of furniture
SU19	Building and construction work
SU20	Health services
SU23	Electricity, steam, gas water supply and sewage treatment
SU24	Scientific research and development
SU0	Other

Source: ECHA 2015

Table 3. ECHA Descriptor list for Chemical Products Category (PC)

Code	Name
PC1	Adhesives, sealants
PC2	Adsorbents
PC3	Air care products
PC4	Anti-Freeze and de-icing products
PC7	Base metals and alloys
PC8	Biocidal products
PC9a	Coatings and paints, thinners, paint removers
PC9b	Fillers, putties, plasters, modelling clay
PC9c	Finger paints
PC11	Explosives
PC12	Fertilizers
PC13	Fuels
PC14	Metal surface treatment products
PC15	Non-metal-surface treatment products
PC16	Heat transfer fluids
PC17	Hydraulic fluids
PC18	Ink and toners
PC20	Processing aids such as pH-regulators, flocculants, precipitants, neutralization agents
PC21	Laboratory chemicals
PC23	Leather treatment products
PC24	Lubricants, greases, release products
PC25	Metal working fluids
PC26	Paper and board treatment products
PC27	Plant protection products
PC28	Perfumes, fragrances
PC29	Pharmaceuticals
PC30	Photo-chemicals
PC31	Polishes and wax blends
PC32	Polymer preparations and compounds
PC33	Semiconductors
PC34	Textile dyes, and impregnating products
PC35	Washing and cleaning products
PC36	Water softeners
PC37	Water treatment chemicals
PC38	Welding and soldering products, flux products
PC39	Cosmetics, personal care products
PC40	Extraction agents
PC41	Oil and gas exploration or production products
PC42	Electrolytes for batteries
PC0	Other

Source: ECHA 2015

Table 4. ECHA Descriptor list for Articles Category (AC)

Code	Name
AC1	Vehicles
AC1a	Vehicles covered by End of Life Vehicles (ELV) directive
AC1b	Other vehicles
AC2	Machinery, mechanical appliances, electrical/electronic articles
AC2a	Machinery, mechanical appliances, electrical/electronic articles covered by the Waste Electrical and Electronic Equipment (WEEE) directive
AC2b	Other machinery, mechanical appliances, electrical/electronic articles
AC3	Electrical batteries and accumulators
AC4	Stone, plaster, cement, glass and ceramic articles
AC4a	Stone, plaster, cement, glass and ceramic articles: Large surface area articles
AC4b	Stone, plaster, cement, glass and ceramic articles: Toys intended for children’s use (and child dedicated articles)
AC4c	Stone, plaster, cement, glass and ceramic articles: Packaging (excluding food packaging)
AC4d	Stone, plaster, cement, glass and ceramic articles: Articles intended for food contact
AC4e	Stone, plaster, cement, glass and ceramic articles: Furniture & furnishings
AC4f	Stone, plaster, cement, glass and ceramic articles: Articles with intense direct dermal contact during normal use
AC4g	Other articles made of stone, plaster, cement, glass or ceramic
AC5	Fabrics, textiles and apparel
AC5a	Fabrics, textiles and apparel: Large surface area articles
AC5b	Fabrics, textiles and apparel: Toys intended for children’s use (and child dedicated articles)
AC5c	Fabrics, textiles and apparel: Packaging (excluding food packaging)
AC5d	Fabrics, textiles and apparel: Articles intended for food contact
AC5e	Fabrics, textiles and apparel: Furniture & furnishings, including furniture coverings
AC5f	Fabrics, textiles and apparel: Articles with intense direct dermal contact during normal use
AC5g	Fabrics, textiles and apparel: Articles with intense direct dermal contact during normal use: bedding and mattresses
AC5h	Other articles made of fabrics, textiles and apparel
AC6	Leather articles
AC6a	Leather articles: Large surface area articles
AC6b	Leather articles: Toys intended for children’s use (and child dedicated articles)
AC6c	Leather articles: Packaging (excluding food packaging)
AC6d	Leather articles: Articles intended for food contact
AC6e	Leather articles: Furniture & furnishings, including furniture coverings
AC6f	Leather articles: Articles with intense direct dermal contact during normal use
AC6g	Other leather articles
AC7	Metal articles
AC7a	Metal articles: Large surface area articles
AC7b	Metal articles: Toys intended for children’s use (and child dedicated articles)
AC7c	Metal articles: Packaging (excluding food packaging)
AC7d	Metal articles: Articles intended for food contact
AC7e	Metal articles: Furniture & furnishings
AC7f	Metal articles: Articles with intense direct dermal contact during normal use
AC7g	Other metal articles
AC8	Paper articles
AC8a	Paper articles: Large surface area articles
AC8b	Paper articles: Toys intended for children’s use (and child dedicated articles)
AC8c	Paper articles: Packaging (excluding food packaging)
AC8d	Paper articles: Articles intended for food contact
AC8e	Paper articles: Furniture & furnishings
AC8f1	Paper articles: Articles with intense direct dermal contact during normal use: personal hygiene articles
AC8f2	Paper articles: Articles with intense direct dermal contact during normal use: printed articles with dermal contact in normal conditions of use

AC8g	Other paper articles
AC10	Rubber articles
AC10a	Rubber articles: Large surface area articles
AC10b	Rubber articles: Toys intended for children’s use (and child dedicated articles)
AC10c	Rubber articles: Packaging (excluding food packaging)
AC10d	Rubber articles: Articles intended for food contact
AC10e	Rubber articles: Furniture & furnishings, including furniture coverings
AC10f	Rubber articles: Articles with intense direct dermal contact during normal use
AC10g	Other rubber articles
AC11	Wood articles
AC11a	Wood articles: Large surface area articles
AC11b	Wood articles: Toys intended for children’s use (and child dedicated articles)
AC11c	Wood articles: Packaging (excluding food packaging)
AC11d	Wood articles: Articles intended for food contact
AC11e	Wood articles: Furniture & furnishings
AC11f	Wood articles: Articles with intense direct dermal contact during normal use
AC11g	Other wood articles
AC13	Plastic articles
AC13a	Plastic articles: Large surface area articles
AC13b	Plastic articles: Toys intended for children’s use (and child dedicated articles)
AC13c	Plastic articles: Packaging (excluding food packaging)
AC13d	Plastic articles: Articles intended for food contact
AC13e	Plastic articles: Furniture & furnishings, including furniture coverings
AC13f	Plastic articles: Articles with intense direct dermal contact during normal use
AC13g	Other plastic articles
AC0	Other

Source: ECHA 2015

Table 5. ECHA Descriptor list for Environmental Release Category (ERC)

Code	Name
ERC1	Manufacture of the substance
ERC2	Formulation into mixture
ERC3	Formulation into solid matrix
ERC4	Use of non-reactive processing aid at industrial site (no inclusion into or onto article)
ERC5	Use at industrial site leading to inclusion into/onto article
ERC6a	Use of intermediate
ERC6b	Use of reactive processing aid at industrial site (no inclusion into or onto article)
ERC6c	Use of monomer in polymerisation processes at industrial site (inclusion or not into/onto article)
ERC6d	Use of reactive process regulators in polymerisation processes at industrial site (inclusion or not into/onto article)
ERC7	Use of functional fluid at industrial site
ERC8a	Widespread use of non-reactive processing aid (no inclusion into or onto article, indoor)
ERC8b	Widespread use of reactive processing aid (no inclusion into or onto article, indoor)
ERC8c	Widespread use leading to inclusion into/onto article (indoor)
ERC8d	Widespread use of non-reactive processing aid (no inclusion into or onto article, outdoor)
ERC8e	Widespread use of reactive processing aid (no inclusion into or onto article, outdoor)
ERC8f	Widespread use leading to inclusion into/onto article (outdoor)
ERC9a	Widespread use of functional fluid (indoor)
ERC9b	Widespread use of functional fluid (outdoor)
ERC10a	Widespread use of articles with low release (outdoor)
ERC10b	Widespread use of articles with high or intended release (outdoor)
ERC11a	Widespread use of articles with low release (indoor)
ERC11b	Widespread use of articles with high or intended release (indoor)
ERC12a	Processing of articles at industrial sites with low release
ERC12b	Processing of articles at industrial sites with high release
ERC12c	Use of articles at industrial sites with low release

Source: ECHA 2015

Table 8. Comparison of Life-cycle stages covered in ESDs and SpERCs

ESD No.	Title	SpERC developer	Intended products	Coverage of life-cycle stage							
				ESD/ SpERC	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal
3	Plastic Additives	International Association for Soaps, Detergents and Maintenance Products (AISE)	Conversion layer	ESD	-	○	-	-	-	○	○
				SpERC	-	-	○	○	○	-	-
		European Association of Metals (Eurometaux) (partial）	Plastic Additives	ESD	-	○	-	-	-	○	○
				SpERC	-	○	○	-	-	-	-
4	Water Treatment Chemicals	European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	Water Treatment Chemicals	ESD	-	-	○	-	-	-	-
				SpERC	○	○	○	-	-	-	-
		International Association for Soaps, Detergents and Maintenance Products (AISE)		ESD	-	-	○	-	-	-	-
				SpERC	-	○	○	○	○	-	-
5	Photographic Industry		Photographic								No SpERC
6	Rubber additives	European Tyre & Rubber Manufactures' Association (ETRMA)	Rubber goods	ESD	-	-	○	-	-	○	-
				SpERC	-	○	○	-	-	-	-
		European Association of Metals (Eurometaux)	Additives	ESD	-	○	-	-	-	○	-
				SpERC	○	○	○	-	-	-	-
		European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	Solvents	ESD	-	○	-	-	-	○	-
				SpERC	○	○	○	○	-	-	-
7	Textile Finishing	German Federation of the Textile Chemical Industry (TEGEWA)	Textile	ESD	○	○	○	-	-	○	-
				SpERC	-	○	○	-	-	○	-
8	Leather processing		Leather	ESD	–	–	○	–	–	–	–

		German Federation of the Textile Chemical Industry (TEGEWA)		SpERC	–	○	○	–	–	○	-

ESD No.	Title	SpERC developer	Intended products	Coverage of life-cycle stage							
				ESD/ SpERC	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal
9	Photoresist Use in Semiconductor Manufacturing		Photoresist								No SpERC
10	Lubricants and Lubricant Additives	European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	Lubricants	ESD	–	○	–	–	–	○	–
				SpERC	○	○	○	○	-	-	-
11	Automotive spray application	European Automobile Manufacturers' Association (ACEA)	Spray painting	ESD	–	–	○	○	–	–	–
				SpERC	–	–	○	–	–	–	–
		Global Federation of National Trade Organizations in the Area of Vehicle Repairs (AIRC)	Vehicle	ESD	–	–	○	○	–	–	–
				SpERC	–	–	○	–	–	–	–
12	Metal finishing	European Association of Metals (Eurometaux)	Metal finishing	ESD	–	–	○	○	–	–	–
				SpERC	○	○	○	-	-	-	-
15	Kraft Pulp Mills		Pulp	No SpERC							
16	Non-Integrated Paper Mills		Paper	No SpERC							
17	Recovered Paper Mills		Recovered Paper	No SpERC							
20	Adhesive Formulation	Association of the European Adhesive & Sealant Industry (FEICA)	Adhesive	ESD	–	○	–	–	–	–	–
				SpERC	–	○	○	○	○	–	–
21	Formulation of Radiation Curable Coatings, Inks and Adhesives	European Sector Group of the Producers and Users of Paints, Printing Inks, Industrial Coatings and Artists' Colours (CEPE)	paints, printing inks, industrial coatings and artists' colours	ESD	–	○	–	–	–	–	–
				SpERC	–	○	○	○	○	–	–
		European Metal Packaging (EMPAC)		ESD	–	○	–	–	–	–	–

			paints and coatings in metal packaging	SpERC	–	○	–	–	–	–	–
		European Federation for Construction Chemicals (EFCC)	adhesive and sealant	ESD	–	○	–	–	–	–	–
				SpERC	–	○	○	○	○	○	–
ESD No.	Title	SpERC developer	Intended products		Coverage of life-cycle stage						
				ESD/ SpERC	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal
22	Coating Industry (Paints, Lacquers and Varnishes)	European Sector Group of the Producers and Users of Paints, Printing Inks, Industrial Coatings and Artists' Colours (CEPE)	Paints, Lacquers and Varnishes	ESD	–	○	○	–	–	○	–
				SpERC	–	○	○	○	○	–	–
		European Metal Packaging (EMPAC)	coatings in strip coating of metals (coil coating)	ESD	–	○	○	–	–	○	–
				SpERC	–	○	–	–	–	–	–
		International Association for Soaps, Detergents and Maintenance Products (AISE)	Paints, Lacquers and Varnishes	ESD	–	○	○	–	–	○	–
				SpERC	-	○	○	○	○	-	-
23	Pulp, Paper and Board Industry		Pulp, Paper and Board								No SpERC
24	Transport and Storage of Chemicals	European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	General chemicals	ESD	○	○	○	–	–	○	○
				SpERC	○	○	○	○	-	-	-
25	Chemicals Used in the Electronics Industry		Chemicals(electronics)								No SpERC
26	Blending of Fragrance Oils into Commercial and Consumer Products		Fragrance Oils								No SpERC
27	Radiation Curable Coating, Inks and Adhesives		Radiation Curable Coating, Inks and Adhesives								No SpERC
28	Metalworking Fluids		Metalworking Fluids	ESD	–	–	○	–	–	–	–

		European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)		SpERC	○	○	○	-	-	-	-
29	Water Based Washing Operations at Industrial and Institutional Laundries	International Association for Soaps, Detergents and Maintenance Products (AISE)	Water base washing	ESD	–	–	○	○	–	–	–
				SpERC	-	○	○	○	○	-	-
ESD No.	Title	SpERC developer	Intended products	Coverage of life-cycle stage							
				ESD/ SpERC	Production	Formulation	Industrial use	Professional use	Private use	Service life	Waste disposal
30	Chemical Industry	European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	General chemicals	ESD	○	○	○	-	-	○	-
				SpERC	○	○	○	○	-	-	-
31	Chemicals used in oil well production	European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	chemicals(oil well)	ESD	–	–	○	–	–	–	–
				SpERC	○	○	○	○	-	-	-
32	Formulation and application of thermal and thermal carbonless copy paper		Thermal and thermal carbonless copy paper								No SpERC
		European Crop protection Association (ECPA)	Plant production products								No ESD
		International Association for Soaps, Detergents and Maintenance Products (AISE)	Soaps, Detergents								No ESD
		European trade association of the cosmetics industry (Cosmetic Europe)	Cosmetics								No ESD
		European Federation for Construction Chemicals (EFCC)	Construction Chemicals								No ESD
		European Solvents Industry Group /Downstream User Coordination Group (ESIG/ESVOC)	Solvents								No ESD

3. Case Studies

3.1. Selecting ESDs and SpERCs for case studies

The project selected two sets of ESD and SpERC for case study analysis.

1. Textile Finishing covering pretreatment, dyeing, printing, finishing and coating/laminating

   - ESD No.7 Textile Finishing Industry (OECD 2004d)

   ESD No.7 Textile Finishing, which was developed by Germany and France as lead countries in 2004, describes the processes of the life cycle stages "industrial and professional use" for all types of chemicals, including biocides, used in textile processing and the emission estimations to local surface water and air. The emission estimation for the life stages "production" and "formulation" were described in the "Technical Guidance Document of Risk Assessment Part II Appendix I, in the A&B-Tables for IC-13" [EU, 2003]. The emission estimation from textile articles during the life cycle stage "service life" is included.

   - SpERC on Industrial applications of textile treatment chemicals (TEGEWA 2009)

   The German Federation of the Textile Chemical Industry (TEGEWA) and the federation of the textile finishing industry developed their SpERCs based on the ESD for their industries (OECD 2004d) in 2009. Several R&D projects and measurements were carried out in textile finishing companies to refine the release fractions for the textiles industry (TEGEWA 2009; Kohla et al. 2008;Sättler et al. 2012)

2. Adhesive[6]

   - ESD No. 20 Adhesive Formulation (OECD 2009a)

   The US EPA developed ESD No. 20 using relevant data and information on the adhesives formulation industry, including process descriptions, operating information, chemicals used, wastes generated, waste treatment, worker activities, and exposure information. The US EPA supplemented the data collected with standard models to develop the environmental release and occupational exposure estimating approaches presented in this ESD.

[6] ESD No. 34, which was published in 2015, covers emission estimation from the use of adhesives. It would be useful to expand the comparison of the FEICA SpERC with ESD No. 34 as well as No. 20. However, the analysis only included ESDs published before the end of 2014. Therefore, No. 34 ESD is not included in the case study.

- SpERC on formulation, industrial use and wide dispersive uses of adhesives and sealants (FEICA 2013a)

The Association of the European Adhesive & Sealant Industry (FEICA) judged the ESD on adhesives (OECD 2009a) to be not sufficient because it was not based on empirical data and not providing sufficient evidence for a quantitative emission estimation. Instead, the ESD for Coatings (OECD 2009c) was used as a starting point to develop release estimations for adhesives, while the former was used for qualitative descriptions of the processes. FEICA argued that the conditions for adhesive and sealant formulation are similar to coatings; thus, the emissions can be read across. In addition, FEICA found the applications to be too specific. Hence, individual applications were aggregated to define broader application types, and worst-case release factors were assigned. [Sättler et al. 2012; Tolls et al. 2015]

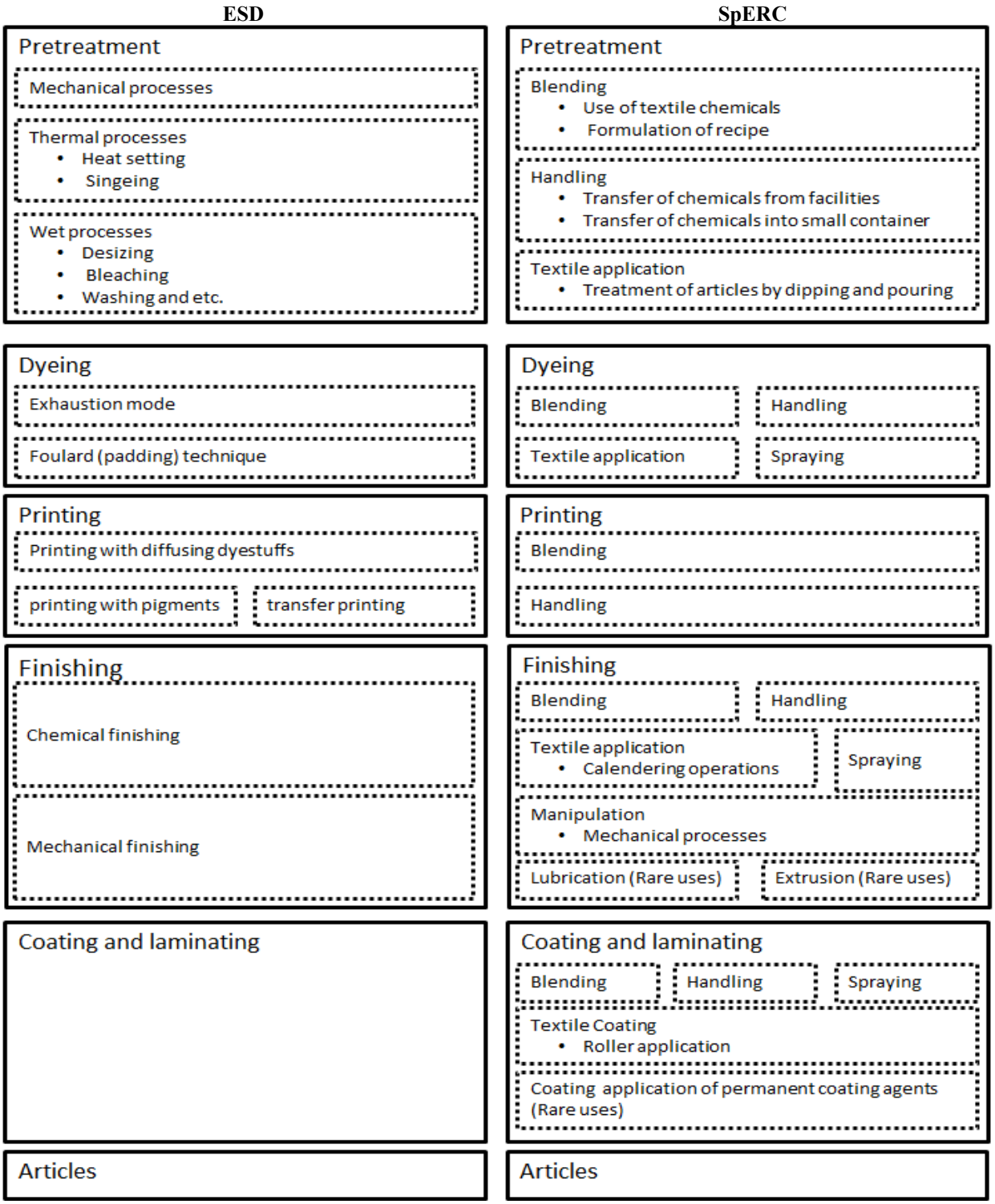
3.2. "Textile Finishing" covers pretreatment, dyeing, printing, finishing, and coating/laminating

3.2.1. Processes

The processes described in the ESD and the SpERC were compared to clarify the similarities and differences of the use description and life-cycle stages (Figure. 1). Each use description in the SpERC was associated with the relevant process in the ESD because the textile processes were not described in the SpERC.

It is clear that the level of details in describing the process was different; for example, the ESD explains the operation process in textile finishing, but this description is not as detailed as what is presented in the SpERCs; the SpERC doesn't describe the textile processes but it outlines activities associated with the operation process.

Figure 1. Comparison of process descriptions between ESD (No.20) and SpERC (TEGEWA) for textile finishing



Note: The SpERC listed "worker activities" and doesn't describe the relationship between "worker activities" and the process for textile finishing, that the ESD mainly covers. This figure was prepared to compare the use description and life-cycle stages in the two documents, assuming that "worker activities" in the SpERC are related to the processes described in the ESD.

3.2.2. Emission sources and emission factors

Factors affecting emission of substances (e.g. rate of fixation on the textile, rate of residual liquors) described in the ESD are summarised in Table 9. Emission factors in the SpERC are shown in Table 10. Factors affecting emission of substances are not described in the SpERC[7]. In addition, information on the mass of substances used per mass of fabric is available as default values in the ESD, while it is not available in the SpERC.

In both the ESD and the SpERC, the chemicals used in textile finishing are expected to be emitted mainly to water. This means that both documents cover the major emission sources and identify emission routes to the environment.

Generally, the emission factors in the ESD are larger than the ones in the SpERC, but some factors are the same or smaller, for example:

- auxiliaries in pigment printing and Dyestuffs in the ESD vs. TEGEWA 1 and TEGEWA 2 in the SpERC;
- auxiliaries in padding functional finishing in the ESD vs. TEGEWA 5 in the SpERC;
- the emission factors of chemicals used in coating in the ESD (Auxiliaries in coating) is smaller than the one in the SpERC (TEGEWA 4); and
- the emission factors of chemicals used in water borne processes in both the ESD and the SpERC are the same.

These results may depend on the following reasons:

- use of a "high end" of actual exposure values (a "reasonable worst case" estimate, the 90th percentile is often used);
- differences in definition of use descriptor or coverage of life-cycle stage between the ESD and the SpERC; and
- differences in predicting certain factors (e.g. degree of fixation, residual liquors) affecting the emission of substances between the ESD and the SpERC.

[7] Note that this project has not analysed all factors affecting emission of substances described in the SpERCs. For example, in the ESIG/ESVOC SpERCs, emission factors depend on physical-chemical properties of substances, especially vapour pressure and water solubility.

Table 6. Emission factors for textile finishing outlined in the ESD

Product	Process	Degree of fixation $F_{fixation}$	Residual liquors $F_{residual\ liquor}$	Release fraction to air	Release fraction to waste water	Release fraction to soil	Model calculation (water)
Auxiliaries	Upstream processes to finishing	0	-	0.0041 - 0.0165	1	n/a	$Elocal_{water} = Q_{textile} \times Q_{product} \times C_{substance} \times (1-F_{fixation})$
Basic chemicals	Pretreatment, dyeing, printing, finishing	0	-		1		
Auxiliaries	Pretreatment	0	-		1		
Auxiliaries not intended to fix on the textile	Exhaust processes	0	-		1		$Elocal_{water} = Q_{textile} \times F_{product} \times Q_{product} \times C_{substance} \times (1-F_{fixation})$
Auxiliaries intended to fix on the textile	Exhaust processes	0.8 (in some cases higher)	-		0.2		
Auxiliaries	Padding functional finishing	1	0.1		0.1		$Elocal_{water} = \{Q_{textile} \times F_{product} \times Q_{product} \times C_{substance} \times (1-F_{fixation})\} + \{Q_{textile} \times F_{product} \times Q_{product} \times C_{substance} \times F_{residual\ liquor}\}$
Auxiliaries	Pigment printing	1	0.25		0.25		
Auxiliaries	Printing (except pigment printing)	0	0.25		1		
Auxiliaries	Coating	1	0.01		0.01		
Dyestuffs	continuous and discontinuous dyeing, printing	0.7-1.0 (Depend on type of dye, process and type of fibre)	cont./semicont. dyeing: 0.1		0.1 - 0.4		
			printing: 0.25		0.25 - 0.55		

Table 7. Emission factors of SpERC for textile finishing

SpERC Name	SpERC description	Release fraction to air	Release fraction to waste water	Release fraction to soil
TEGEWA 1	TEGEWA - Dyeing of Textiles - High efficiency	0	0.05	0
TEGEWA 2	TEGEWA - Dyeing of Textiles - Normal efficiency	0	0.3	0
TEGEWA 3	TEGEWA - Textile Finishing and Coating - Residues not retained	0.001	0.2	0
TEGEWA 4	TEGEWA - Textile Finishing and Coating - Residues retained	0	0.05	0
TEGEWA 5	TEGEWA - Use of reactive processing aid in textile processing	0	0.02	0
TEGEWA 6	TEGEWA- Industrial Use of Water Borne Processing Aids - no RMM	0	1	0

Source: CEFIC 2010

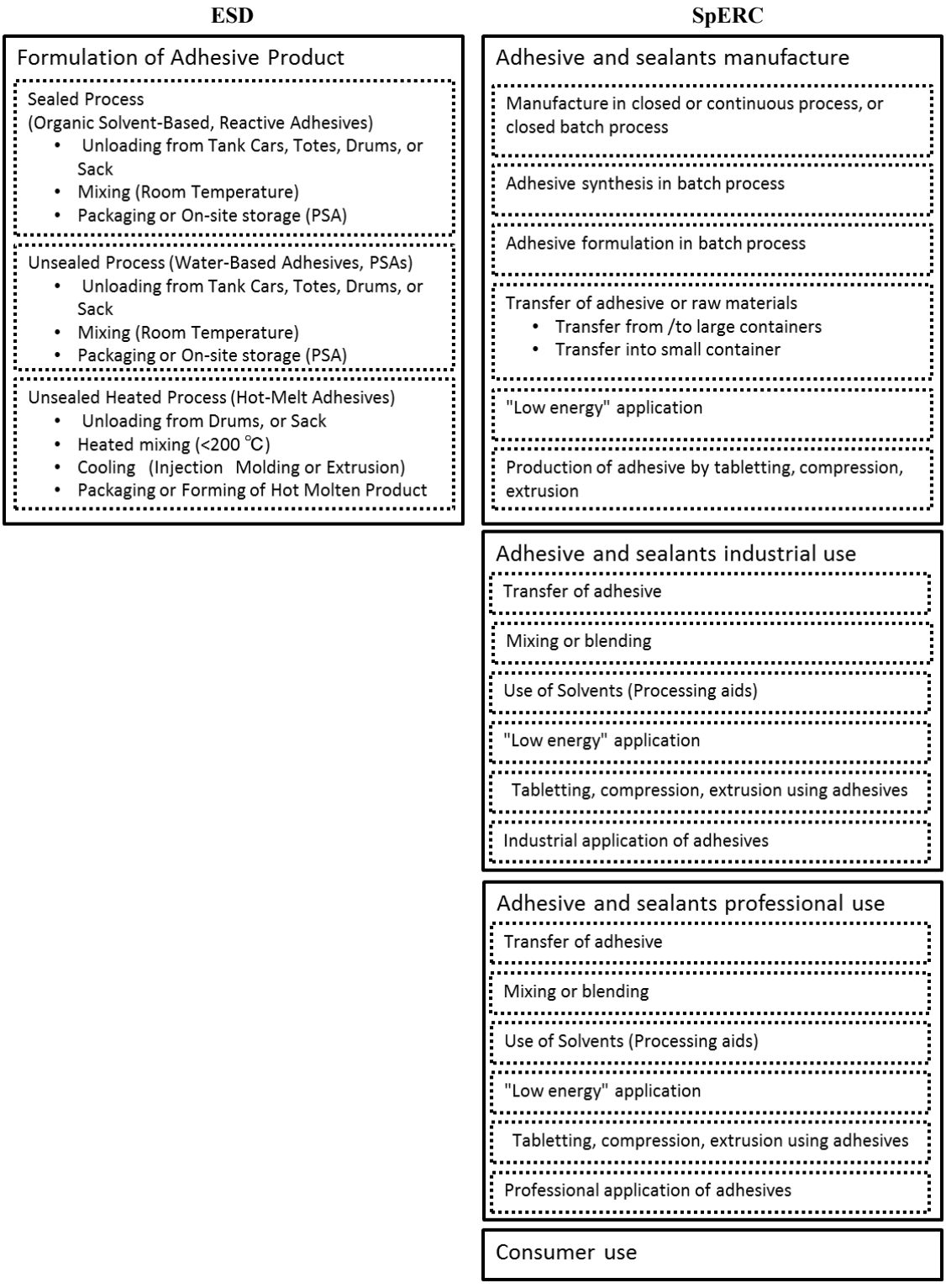
3.3. Adhesives

3.3.1. Processes

The processes described in the ESD and the SpERC are compared in Figure 2. The life-cycle stages of industrial use, professional use and private use are not described in the ESD but separate SpERCs exist for these life cycle stages. The release factors during formulation, industrial, professional and private use in the SpERC were read across from the ESD for the coating industries (OECD 2009c).

Although three different types of adhesive products were described in the ESD, the use descriptions in the SpERC were divided into volatiles / non-volatiles and solvent vs. water based products. As for textile finishing, the ESD explains the process for formulating adhesive products, but this description is not as detailed as in the SpERCs.

Figure 2. Comparison of processes between the ESD and the SpERC for adhesives



3.3.2. Emission sources and emission factors

The ESD presents methodologies and factors affecting the emission of chemicals to estimate the amounts released, and this information is summarized in table 11. They rely on a release model from the US-EPA. The emission factors in the SpERC are shown in table 12. The SpERC for adhesives uses the the emission factors described in the ESD for coating industry (paints, lacquers and varnishes) (OECD 2009c) as:

1. regarding environmental emission, formulation, industrial use and professional use of adhesives and sealants are very similar to those for paints, lacquers and varnishes;
2. the emission factors in the ESD for paints lacquers and varnishes were based on realistic data (FEICA 2013b).

In addition, information on the tonnage of chemicals used in adhesive formulation is available as default values in the ESD. Typical substances use rates are also available in the SpERC.

The volatile chemicals used in adhesives are expected to be emitted to air in both the ESD and the SpERC. Exposure to water and soil are negligible. It is considered that both documents cover major emission sources and identify emission routes to the environment.

The main factor affecting emission of substances in the ESD seemed to be vapour pressure of chemicals used in adhesives. Although 11 release sources in adhesive formulation were identified in the ESD, the SpERCs address the total sum of releases from the combined 'sources' during formulation, industrial and professional use per product type and per substance category to build a broad application scope for a lower tiered exposure assessment. Emission factors in the SpERCs are set for each life-cycle stage, such as formulation to serve REACH requirements.

Table 8. Emission sources and factors for adhesive formulation outlined in the ESD

No.	Process	Description	Model calculation	SpERCs assumed to correspond to emissions sources in ESD	
				Code	Short description of process or activity
1	Unloading from Tank Cars, Totes, Drums, or Sacks	Container residue released to non-air media	$Elocal_{container\_residue\_disp} = Q_{cont\_empty} \times F_{chem\_comp} \times F_{container\_residue} \times N_{cont\_empty\_site\_day}$ If the annual number of containers emptied ($N_{cont\_empty\_site\_day}$) is greater than the days of operation ($TIME_{working\_days}$), more than one container is unloaded per day. $Elocal_{container\_residue\_disp} = Q_{chem\_site\_day} \times F_{container\_residue}$	FEICA-UseR 10-16,17,18	Transfer of adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
2		Open surface losses of volatile chemical to air during container cleaning	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OPPT Penetration Model	FEICA-UseR 10-16,17,18	Transfer adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
3		Transfer operation losses of volatile chemical to air during unloading	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OAQPS AP-42 Loading Model	FEICA-UseR 10-16,17,18	Transfer adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
4		Dust losses of solid chemical during unloading	Liquid adhesive components: negligible Solid adhesive components: release to air as the following $Elocal_{dust\_captured} = Q_{chem\_site\_day} \times F_{dust\_generation} \times (1-F_{dust\_control})$	FEICA-UseR 10-16,17,18	Transfer adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
5	Mixing (and Cooling)	Vented losses of volatile chemical to air during process operations	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OPPT Penetration Model	FEICA-UseR 10-1,2,3	Adh. manufacture in closed or continuous process
				FEICA-UseR 10-4,5,6	Adhesive manufacture in closed batch process
				FEICA-UseR 10-7,8,9	Adhesive synthesis in batch process
				FEICA-UseR 10-10,11,12	Adhesive formulation in batch process
6		Adhesive product sampling wastes disposed to non-air media	Relatively low in comparison to the other sources of release in the adhesive formulation process.	FEICA-UseR 10-1,2,3	Adh. manufacture in closed or continuous process
				FEICA-UseR 10-4,5,6	Adhesive manufacture in closed batch process
				FEICA-UseR 10-7,8,9	Adhesive synthesis in batch process
				FEICA-UseR 10-10,11,12	Adhesive formulation in batch process
7		Open surface losses of volatile chemical to air during product sampling	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OPPT Penetration Model	FEICA-UseR 10-1,2,3	Adh. manufacture in closed or continuous process
				FEICA-UseR 10-4,5,6	Adhesive manufacture in closed batch process
				FEICA-UseR 10-7,8,9	Adhesive synthesis in batch process
				FEICA-UseR 10-10,11,12	Adhesive formulation in batch process
8				FEICA-UseR 10-1,2,3	Adh. manufacture in closed or continuous process

		Equipment cleaning residues released to non-air media	If known number of cleanings is fewer than the days of operation : $Elocal_{equipment\_cleaning} = Q_{adhes\_bt} \times F_{chem\_comp} \times F_{comp\_adhes} \times N_{bt\_site\_day} \times F_{equipment\_cleaning}$ If known number of cleanings is greater than the days of operation: $Elocal_{equipment\_cleaning} = Q_{chem\_site\_day} \times F_{equipment\_cleaning}$	FEICA-UseR 10-4,5,6	Adhesive manufacture in closed batch process
				FEICA-UseR 10-7,8,9	Adhesive synthesis in batch process
				FEICA-UseR 10-10,11,12	Adhesive formulation in batch process
9		Open surface losses of volatile chemical to air during equipment cleaning	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OPPT Penetration Model	FEICA-UseR 10-1,2,3	Adh. manufacture in closed or continuous process
				FEICA-UseR 10-4,5,6	Adhesive manufacture in closed batch process
				FEICA-UseR 10-7,8,9	Adhesive synthesis in batch process
				FEICA-UseR 10-10,11,12	Adhesive formulation in batch process
10	Packaging or On-site storage (Forming of Hot Molten Product)	Transfer operation losses of volatile chemical to air during product container loading	The vapour pressure is < 0.001 torr: negligible The vapour pressure is > 0.001 torr: Use EPA/OAQPS AP-42 Loading Model	FEICA-UseR 10-16,17,18	Transfer of adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
				FEICA-UseR 10-22,23,24	"Low energy" application of adhesives
				FEICA-UseR 10-25,26,27	Prod. of adhesives by tabletting, compression, extrusion
11		Off-spec product wastes disposed to non-air media	$Elocal_{off\text{-}spec} = Q_{adhes\_bt} \times F_{chem\_comp} \times F_{comp\_adhes}$	FEICA-UseR 10-16,17,18	Transfer of adh. or raw materials from/to large containers
				FEICA-UseR 10-19,20,21	Transfer adh. or raw materials into small containers
				FEICA-UseR 10-22,23,24	"Low energy" application of adhesives
				FEICA-UseR 10-25,26,27	Prod. of adhesives by tabletting, compression, extrusion

Table 9. Emission factors in the SpERC for adhesives

SpERC Name	SpERC description	Release fraction to air	Release fraction to waste water	Release fraction to soil
FEICA 1	Formulation of Solventless/Solvent Borne Adhesives -Solids	0.01	0.00005	0
FEICA 2	Formulation of Solvent Borne Adhesives – Volatiles (Large Scale, > 1000 t/a)	0.0012	0	0
FEICA 3	Formulation of Solvent Borne Adhesives – Volatiles (Small Scale, < 1000 t/a)	0.036	0	0
FEICA 4	Formulation of Water Borne Adhesives – Volatiles	0.022	0.005	0
FEICA 5	Formulation of Water Borne Adhesives – Solids	0.01	0.005	0
FEICA 6	Industrial Use of Solvents in Paper, Board and related Products / Woodworking and joinery / Footwear and Leather, Textile, Others Adhesives	0.985	0	0
FEICA 7	Industrial Use of Solvents in Transportation (Automotive/aircraft/rail vehicles) / industrial Building Construction Adhesives	0.985	0	0
FEICA 8	Industrial Use of Substances other than Solvents in Paper, Board and related Products / Woodworking and joinery / Footwear and Leather, Textile, Others Adhesives	0.017	0	0
FEICA 9	Industrial Use of Substances other than Solvents in Transportation (Automotive/aircraft/rail vehicles) / industrial Building Construction Adhesives	0.017	0	0
FEICA 10	Industrial Use of Substances other than Solvents in water borne adhesives	0	0.003	0
FEICA 11	Wide dispersive Use of Solvents in Adhesives and Sealants	0.98	0.015	0

4. Summary and recommendations

4.1. Findings from the analysis

The project concluded that there is no one-to-one alignment of SpERCs and ESDs, and that there is not always a one to one alignment with the SpERC life-cycle stages and ESD life-cycle stages.

As a result of the two case studies, the following similarities of ESDs and SpERCs were identified:

- The main emission sources and routes as well as the environmental media (e.g. air, water) receiving the main emissions are well identified; and
- The key physical-chemical properties that mostly affect the emission factors are highlighted.

On the other hand, a number of quantitative and qualitative differences were identified:

- The categories for life-cycle stages used in the guidance document for developing ESDs are slightly different from those used in the guidance documents for implementing REACH. For example, the ESD-category "painting" can correspond to the SpERC category "industrial use", "professional use" and "private use". (e.g. car painting in the automotive manufacturing plant, car repainting by a garage mechanic, car repainting by a car owner, wood painting in the plant, painting of wood furniture by a carpenter, wood house painting by its owner);
- The granularity of differentiating between processes (and the related chemicals and conditions of use) can be different between SpERCs and ESDs;
- To estimate emission, model formulas often lack defined emission factors in the ESDs, while emission factors associated with the conditions of use are defined in the SpERCs; and
- ESDs aim to provide emission estimation at each life-cycle stage, while it is not the purpose of a SpERC to provide direct emission estimation but to provide quantitative exposure parameter (e.g. release factors, etc.) for a specific application during a life cycle step. Using these parameters, a risk assessor estimates the risk potential from the exposure caused by a distinct use.

4.2. Recommendations for further collaboration between ESDs and SpERCs

European Union regulators and industry agreed on improving SpERCs further (Ahrens, A. et al., 2017). Also, based on the result of this analysis, SpERCs could be improved on the following points:

- For each SpERC a published background document should be available, describing the conditions of use driving the release and explaining how the release factors were derived;

- SpERCs should be incorporated into use-maps so that it is traceable to which uses they refer and that they can be connected to the corresponding conditions of use from a worker and consumer perspective; and
- The work processes used to determine release factors should be described and use descriptions should be related to work processes.

ESDs could be improved on the following points:

- The life-cycle stage covered by the ESDs should be better defined (note that the ESD's guidance document requests that the ESDs include different life-cycle stages), especially regarding industrial use, professional use and private use;
- Their background information and data should be updated based on a new analysis of best available techniques;
- Background information should be provided to make it clear where the default is derived from when emission estimations are conducted by default model assumptions; and
- New ESDs should be developed to fill gaps on use and life-cycle stages identified in this document.

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