Ministry of Environment and Food
The Danish Environmental Protection Agency

Survey and health assessment of UV filters

Survey of chemical substances in consumer products No. 142, 2015

Title: Survey and health assessment of UV filters

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Foreword

This study is part of the Environmental Agency's programme for surveying chemicals in consumer products. The programme focuses on problematic substances in consumer products and the results of the surveys are used for advice and regulation.

The overall questions to be addressed in this project are:

- What UV filters and UV absorbers are used and where?
- What type of UV radiation do they protect against?
- What is the exposure of consumers?
- What are the applications of UV filters and UV absorbers found in human biomonitoring studies and in the environment?
- Do these substances have other unwanted health effects than potential endocrine disrupting effects?
- Are the substances of concern in the environment?
- Is there a risk to consumers' health?

The project does not include a detailed assessment of endocrine disrupting effects, but assessments carried out by CeHOS, Danish Centre on Endocrine Disrupters (Hass et al., 2012 and Axelstad et al., 2013) are included in the hazard and risk assessments.

Project was carried out from October 2013 to August 2015 as a collaboration between COWI A/S (project management, survey, part of the health assessment, quality control), Building Research Establishment Ltd, UK (environmental assessment) and DTU Food (part of the health assessment). Moreover, the Danish Technological Institute has participated in clarifications of opportunities to conduct chemical analyses of selected UV filters and UV absorbers. However, a decision was made not to carry out chemical analyses as part of the project.

The project was overseen by a steering committee with the following members:

- Bettina Ørsnes Larsen, Environmental Protection Agency (took over the project in May 2014, following Louise Fredsbo Karlsson, Environmental Protection Agency)
- Marie Louise Holmer, Environmental Protection Agency
- Sonja Hagen Mikkelsen, COWI.

Summary and conclusion

Background and purpose
UV-protective substances are used to prevent the harmful effects of UV radiation to different materials and to human skin. The substances are added to both cosmetics and other chemical products (mixtures), and are also included in materials used in various articles. The use of UV filters and UV absorbers may depending on the specific application result in exposure of consumers. Recent studies have given rise to increased concern for safety associated with some of the UV filters used in sunscreens and other cosmetic products, and exposure associated with their use in other product types. Several studies have demonstrated the presence of UV filters in the environment, the accumulation of lipophilic UV filters in biota and presence in breast milk and urine of children, even in the winter months when the children are not expected to be exposed to sunscreen products with UV protection. Therefore, it is uncertain which other applications may contribute significantly to their exposure.

The overall aim of the project is to map the occurrence of UV filters and UV absorbers in cosmetics and other products that may lead to consumer exposure, and to assess the extent to which the application could give rise to exposure of consumers and unwanted effects on the environment and human health. Furthermore, it has been the aim to identify which UV-protective substances may can be considered sufficiently well-described and safe to use in relation to the possible effects on the environment and consumers, and to identify any missing data that may help to qualify the assessments.

Survey
The survey is based on information from the Internet, the scientific literature, available REACH registration information, non-confidential information from the Danish Product Register and the SPIN database (professional use of raw materials and chemical products containing UV filters and UV absorbers) and from market actors contacted directly or through their respective industry associations. Among the market actors, suppliers of raw materials, compounders, and suppliers of chemical products and articles are covered.

The survey includes UV filters and UV absorbers. UV filters are substances, which are intended to protect the underlying material (which also includes the skin) against adverse effects of UV radiation. UV absorbers are substances, which absorb UV rays, and are added to or applied to a variety of products and materials, in order to prevent that the materials themselves are degraded by UV radiation. UV absorbers are a subset of the UV stabilizers and typically comprise benzophenones, benzotriazoles, salicylates and similar substances. There are other types of UV stabilizers, which act through different mechanisms, and which are widely used in plastics and other materials (e.g. anti-oxidants and hindered amines - HALS). These other types of UV stabilizers which are not used in cosmetics have not been covered in this study.

Only substances included in the positive list of UV filters in Annex VI to the Cosmetics Regulation may be used with this function in cosmetics up to the maximum allowed concentration. A number of UV filters may also be used as UV absorbers or have other functions in cosmetics products. Therefore, more UV protective substances may be found in each product. For product types other than cosmetics, the substances are typically used in significantly lower concentrations than in sunscreen.

Cosmetics
Contact with suppliers of cosmetics on the Danish market resulted in relatively sparse information. In order to supplement the information received from market actors, 11 shops were visited, including one pharmacy during June/July 2014. The list of ingredients on products expected to contain UV protection as well as a range of other products were checked. The review showed that UV filters and in particular UV absorbers were found in many different types of cosmetic products; including products which are not expected to be significantly affected by sunlight. Examples of products using approved UV filters are makeup remover, face cream, balm, eau de toilette, foundation, hand cream, hair treatment, hair oil, lip balm, makeup, perfume, shampoo / conditioner, sunscreen and eye cream. The explanation may be that many UV filters and UV absorbers also have other functions, including masking undesirable odours from the products. Among the 291 products identified as containing UV filters or UV absorbers, sunscreen products were the group containing the most miscellaneous UV protecting substances. A total of 24 UV-protective substances were represented in sunscreens. Face creams contained 16 different UV-protective substances and foundation seventeen. A single sunscreen product only contained a UV filter which is unapproved and the product was consequently notified to the Chemicals Inspectorate. The product contained zinc oxide, which has many functions in cosmetics, including UV absorption, skin protection, bulking and as an approved dye. Zinc oxide is expected to be approved as a UV filter in the future, since it is considered safe to use by EU's Scientific Committee on Consumer Safety (SCCS).

The shop visits showed that among the 291 products containing UV protective substances, most products contained:

- Butyl methoxydibenzoylmethane (BMDBM), CAS no. 70356-09-1 (119 products)
- Benzyl salicylate, CAS no. 118-58-1 (87 products)
- Ethylhexyl salicylate, CAS no. 118-60-5 (84 products)
- Octocrylene (OC), CAS no. 6197-30-4 (76 products), and
- Ethylhexyltriazone, CAS no. 88122-99-0 (73 products).

Of these substances, BMDBM and OC have been detected in human biomonitoring studies, in drinking water and in the environment, as is discussed in more detail further below.

Textiles
With regard to textiles, the survey suggests that it is primarily automotive textiles, awnings and outdoor fabrics that have UV filters added. According to the feedback from Danish market actors, UV protection of clothes on the Danish market is achieved through garment weaving. However, it has generally been difficult to obtain the requested information, as suppliers often have to go far back in the supply chain in order to retrieve the data.

It was not possible to obtain information about the contents of chemical products applied to textiles to achieve UV protection. However, the survey has identified information from the literature on the most commonly used UV filters and UV absorbers in textiles, including nano titanium dioxide.

Toys
In relation to plastic materials the survey among market actors provided most results for toys. Based on information from the European association of toy industries, TIETOY, it appears that most UV-protective substances are used in indoor plastic toys. According to the industry benzophenone-12 (CAS no. 1843-05-6) is one of the substances found in the highest concentration (5.2%). As well, however, a substance such as Fluorescent Brightener 367 (CAS no. 5089-22-5) occurs in concentrations of 5% in plastic parts. TIETOY also informed the authors that benzophenone (CAS no. 119-61-9), which is a photoinitiator, may be included at levels up to 1.4% in

the paint on interior plastic toys, and that 2,2-dimethoxy-2-phenylacetophenone (CAS no. 24650-42-8) may be included at levels up to 10% in ink.

Food Packaging
UV-absorbers and UV filters are added to food packaging to protect both the packaging and the contained food from harmful UV light. It has been shown that these substances are able to migrate from the packaging to food and beverages. Measurements have demonstrated a wide range of UV filters or UV absorbers in PET bottles, and benzophenone-1 (CAS no. 131-56-6) and benzophenone-3 (CAS no. 131-57-7) in packaging of various other types of plastics.

It was not possible to confirm the use of UV protective substances in food packaging (for example, in PET bottles) in Denmark through contact either to market actors or to laboratories.

Other articles of plastics and other polymers
Feedback from suppliers of outdoor plastic products, including both garden furniture and playground equipment such as plastic slides and swings, did not indicate use of any UV-protective substances of the types covered by the present project, but rather use of stabilizers based on different mechanisms of action. However, the substances mentioned for use in plastic toys are probably also used for plastics in other applications.

Paints, varnishes, adhesives, sealants
According to the SPIN database, various benzophenone derivatives (including benzophenone-3 and benzophenone-12) and benzotriazoles are the UV filters that are registered in the largest quantities in paints and varnishes in the Danish Product Register. This is confirmed by information obtained through the Danish Coatings and Adhesives Association (Danmarks Farve- og Limindustri, DFL). According to information from industry, the UV-protective substances are included in paints and varnishes in concentrations between 0.1 and 3%, but mostly between 0.1 and 1.0% - the highest concentrations reported are for outdoor wood oil / wood protection. UV stabilizers are included in assembly adhesives in concentrations of 0.1 to 0.25%, and in sealants, in concentrations from 0.04 to 0.25%. These UV filters are typically used only in this type of product.

Printing inks
A single manufacturer of printing inks has stated that UV absorbers are only used for the following two applications:

- For industrial products to be used outdoors - for example, road signs - UV-absorbers based on benzotriazoles are typically used.
- For UV-curing printing inks and varnishes, where the substances act as photoinitiators (UV-curing agents), a number of substances, including benzophenone and benzophenone derivatives are used. The UV-curing printing inks are used for a variety of purposes, including printings on food packaging.

The Danish Veterinary and Food Administration has filed a report from a project where types of packaging for dry foods were selected for analysis on the basis of knowledge or suspicion of use of prints with UV-curable inks. Benzophenone was found in most samples in concentrations of up to 20 μg/dm^2; the highest concentration which was found was in a package for fast food. Migration tests showed no findings of photoinitiators above regulated levels.

Cleaning products and detergents
Neither of the two producers, contacted as part of the survey, used UV-protective substances in their products. The industry association had no knowledge available regarding the use of UV filters and UV absorbers or whether there could be other producers using these substances in their cleaning agents, or which substances these may include. For some of the substances (as shown in

Appendix 3) cleaning products and detergents are included among the registered product categories. However, these statements do not provide reliable evidence for actual use for cleaning products; on this basis, it cannot be excluded that the UV filters are used in cleaning products and detergents on the Danish market, but the use does not appear to be widespread.

Consistency between the results of the survey and the substances found through human biomonitoring, in drinking water, and in water and biota

As part of the survey, a literature review has been carried out regarding UV filters and UV absorbers found in human biomonitoring studies, in drinking water, and in water and biota, primarily within the EU. This information is combined with the information available on the use of substances.

Compounds found through biomonitoring

Five out of six substances detected in biomonitoring studies, are also found in cosmetics as part of the survey, probably because the substances that have been included in the biomonitoring studies typically are substances used in cosmetics, which are also suspected of having endocrine disrupting properties. One of the substances found through biomonitoring (4-MBC) is not identified in the shop survey of cosmetic products, but is described as being used in cosmetics in the literature. The results from the survey suggest that 4-MBC is not likely to be used in cosmetic products on the Danish market today. Danish biomonitoring studies have measured BP-3, 4-MBC and OMC, which may originate from UV filters, in urine.

Three of the substances (OD-PABA, OMC and HMS), are only found in cosmetics in this survey and not in the other product types. The substances are found in a wide range of cosmetic products and their use is not limited to sunscreens and other cosmetic products, where there is a particular need for sun protection, and where a seasonal use of the products is expected. The presence of these substances in the different cosmetic products would explain why no seasonal variations in the concentrations are found in biomonitoring measurements. According to the survey, two of the substances (BP-3 and OD-PABA) are also used in paints and lacquers; BP-3 is used in plastics, and OD-PABA is used in printing inks. These substances have also been found in drinking water and in the environment. The applications in paints, lacquers, plastics and inks are also likely to contribute to the exposure of humans. The lack of detection of the other UV filters may very well be because, generally, the biomonitoring studies only have included substances used in cosmetics.

Substances detected in drinking water

The substances which are detected in the human biomonitoring studies are generally also found in drinking water and in the environment, for instance in Europe. All of the investigations of drinking water concerns drinking water extracted from surface water (rivers and lakes), which are assumed to be used for recreational purposes. The Danish drinking water supply is based almost entirely on groundwater.

In addition to the substances found in the biomonitoring studies, BP is also found in drinking water.

The substance (BP) is not found in cosmetics in this survey and is not among the substances allowed for use as UV filter in cosmetics. On the other hand, it is widely used in plastics (including plastic toys and food packaging) and paint/lacquers and inks (including food packaging). Results show that the substances which are not used in cosmetics can be found in drinking water (from surface water), and that it is quite possible that there could be more substances identified if they were included in the analyses.

No studies investigating the presence of the substances in drinking water or surface water in Denmark have been identified.

Substances found in the environment
In addition to the six substances that have been identified through human biomonitoring, five substances have been detected in the aquatic environment, and/or biota. Of these other substances, one substance, BMDBM, is used in cosmetics. This substance was the most frequently identified substance in the survey of cosmetic products. Furthermore, it is identified as used in toys. With the frequent occurrence in cosmetics, it is most likely that this use is the reason for its presence in the aquatic environment. The other substances (UV-234, UV-328, UV 327 and UV-329) are not found in cosmetics and are not approved UV filters in cosmetics. They are all used in plastics (including some of the substances listed for use in plastic toys and food packaging), and two of the substances are also identified as used in paints and lacquers. These substances primarily end up in the environment via waste water and sludge.

The fact that these substances, which are not used in cosmetics, can be found in the aquatic environment and biota indicates that other UV-protective substances could very well be present in the environment, and if analysed for, detected. No information on measurements of UV-protective substances from the Danish environment has been identified.

Environmental hazard assessment
The environmental hazard assessment provides a brief summary of the immediately available information on the environmental hazards associated with the 19 selected UV-protective substances. The aim of the overview is to identify which of the 19 substances are likely to be persistent, bioaccumulative and toxic in the environment. As part of the assessment, the properties of the substances are compared with the criteria in Annex XIII of the REACH Regulation, which is used to identify substances that are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB). On the basis of the screening, substances are divided into a number of groups based on the information on PBT/vPvB properties, and the degree of available data.

The evaluation of the substance properties can be characterized as a screening and is primarily based on data available in the REACH registration dossiers which are not assessed by ECHA or other EU expert groups. The information here is taken at face value and validity is not further assessed by the authors of this report.

- Substances unlikely to meet the Annex XIII criteria for PBT or vPvB:
    - Benzophenone-3 (BP-3) (CAS no. 131-57-7)
    - Benzophenone-1 (BP-1) (CAS no. 131-56-6)
    - Diethylamino hydroxybenzoyl hexyl benzoate (CAS no. 302776-68-7)
    - Diethylhexyl butamido triazone (CAS no. 154702-15-5)
    - Ethylhexyl methoxycinnamate (OMC) (CAS no. 5466-77-3)
    - Terephthalylidene dicamphor sulfonic acid (CAS no. 92761-26-7)
    - Isoamyl p-methoxycinnamate (CAS no. 71617-10-2)
    - Benzophenone (BP) (CAS no. 119-61-9)

- Substances potentially meeting Annex XIII screening criteria for PBT and vPvB:
    - 4-Methylbenzylidenkamfer (4-MBC) (CAS no. 36861-47-9)

- Substances potentially meeting Annex XIII screening criteria for vPvB:
    - 2-Ethylhexyl-4- (dimethylamino) benzoate (PABA OD) (CAS no. 21245-02-3)

- Substances for which the available data did not lead to a conclusion on the PBT or vPvB status:
    - Octocrylene (OC) (CAS no. 6197-30-4)
    - Titanium dioxide (CAS no. 13463-67-7)

- Butyl methoxy-dibenzoylmethane (BMDBM) (CAS no. 70356-09-1)
- Ethyl salicylate (CAS no. 118-60-5)
- Ethylhexyl triazone (CAS no. 88122-99-0)
- Bis-ethylhexyloxyphenol methoxyphenyl triazine (BEMT) (CAS no. 187393-00-6)
- Homosalate (HMS) (CAS no. 118-56-9)
- Drometrizol trisiloxane (CAS no. 155633-54-8)
- Benzophenone-12 (CAS no. 1843-05-6)

PBT and vPvB substances
The two substances for which there is sufficient knowledge to assess the potential PBT or vBvP status (4-MBC and OD PABA) are among the substances detected in drinking water and in the aquatic environment in international studies. The substance 4-MBC is not identified in the shop survey of cosmetic products, but in literature it is described as used in cosmetics, while OD-PABA is found in two products in the shop survey and is also used in paints/lacquers and printing inks (including printing inks for food packaging).

There are two UV-protective substances that are not assessed in this study which have been included in the candidate list under REACH due to their PBT properties. These are 2-benzotriazol-2-yl-4,6-di-tert-butyl phenol (UV-320) (CAS no. 3846-71-7) and 2- (2H-benzotriazol-2-yl) -4, 6-ditertpentylphenol (UV-328) (CAS no. 25973-55-1). Both substances are used in plastic, and UV-328 is also identified as used in the paint/lacquers.

Health Effects
Among the 19 UV-protective substances that are selected to be assessed in this study, 16 are approved UV filters in cosmetics. The three other substances (BP, BP-1 and BP-12) are all listed as UV absorbers in the EU Cosing (Cosmetic Ingredients) database, but only BP-1 is registered under REACH for use in cosmetics and personal care products. Only one of the 19 substances has a harmonised health classification; the classification is serious eye damage (Eye Dam. Category 1, H318). For six of the 19 substances, the industry has suggested classifications for skin and eye irritating properties, sensitizing properties and specific target organ toxicity by single or repeated exposure. The notifiers are not always in agreement regarding the classification and not all have suggested the same hazard classes or the same category within each hazard class.

For many of the 19 UV-protective substances the amount of data is limited and largely available from the public part of the REACH registration dossiers. Consequently, the assessment of 12 of the 19 selected substances is primarily or exclusively based on incomplete data from the industry. Eleven of these substance evaluations are based on REACH dossiers and one assessment is based on data from the Australian NICNAS. Two of the 19 UV-protective substances are currently only pre-registered under REACH and the limited data is available in the open literature. Five UV filters are evaluated by a scientific committee which considers that sufficient information is available for an evaluation as safe to use in contact with skin, in accordance with the limitations provided in the Cosmetics Regulation Annex VI (BP-3, 4-MBC, TiO2, diethylamino hydroxybenzoyl hexyl benzoate and HMS).

The information taken from the REACH registration dossiers has not been evaluated by a scientific committee and is not reproduced in sufficient detail to allow for an assessment. The information from the dossiers is therefore taken at face value, including the NOAEL (No Observed Adverse Exposure Level) used to calculate the margin of safety between the no-effect levels and the estimated systemic exposure dose (SED).

For one substance, drometrizol, which is only pre-registered under REACH, limited data on toxicity is identified in the open literature.

Suspected endocrine disruptors
The following of the selected substances are suspected endocrine disrupters with relevance for both the environment and health:

- Benzophenone-3 (BP-3) (CAS no. 131-57-7)
- Octocrylene (OC) (CAS no. 6197-30-4)
- Benzophenone-1 (BP-1) (CAS no. 131-56-6)
- 4-Methylbenzylidene camphor (4-MBC) (CAS no. 36861-47-9)
- Ethylhexyl methoxycinnamate (OMC) (CAS no. 5466-77-3)
- Isoamyl p-methoxycinnamate (CAS no. 71617-10-2)
- Benzophenone (BP) (CAS no. 119-61-9)
- Benzophenone-12 (BP-12) (CAS no. 1843-05-6)

These substances are all to be further assessed in the near future under REACH, also with regard to their potential endocrine disrupting properties.

Human exposure and health risk assessment
Based on the survey and the publicly available information from REACH registration dossiers and notifications to the Danish Product Register, it is not possible to draw a complete picture of actual consumer exposure to UV filters and UV-absorbers in different product types. In general, there may be many different uses of each substance, both within the cosmetics product group, and in connection with other products for those substances with wider applications. Results from human biomonitoring studies and investigations of aquatic environments and biota demonstrate that exposure takes place, and that cosmetics are a contributing factor.

Cosmetic products are generally considered safe to use when the calculated margin of safety (MOS) based on the NOAEL, possibly the LOAEL established during the health assessment, and the estimated systemic exposure dose (SED), is greater than 100. Although there is uncertainty about some of the data which have been available in this project for most of the UV filters, e.g. the NOAEL and information on skin absorption, risk assessments have been carried out on the present basis. The risk assessments are therefore more indicative and not considered complete, but they may be used to focus future efforts. Calculations are based on two scenarios, one with application of sunscreen in amounts of 18 to 36 g per day and a scenario that takes into account the aggregate exposure from other uses of the substances in cosmetics (worst case).

The quantitative assessment of risk associated with the use of sunscreen products and the total exposure to other cosmetic products, respectively, based on the collected health data, provided the following results. The UV filters in bold lettering, are the filters that are found in more than 50 individual products in the shop survey of cosmetic products. The UV filters in italic lettering, are the UV filters found in most sunscreen products in the shop survey:

- Based on the available data, the risk calculations performed in this project as well as an expert assessment of one of the substances indicate that 11 UV filters are safe to use for the consumer in the indicated dose:
    - ***Butyl methoxy dibenzoyl methane (CAS No. 70356-09-1)***
    - ***Titanium dioxide (CAS no. 13463-67-7) (evaluated by an expert)***
      (For titanium dioxide a risk calculation was not carried out, either in the project or by the group of experts who have assessed the substance, since there is no evidence of absorption through the skin.)
    - ***Ethylhexyl salicylate (CAS No. 118-60-5)***
    - ***Ethylhexyl triazone (CAS no. 88122-99-0)***
    - ***Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)***

- ***Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)***
- *Diethylhexyl butamido triazone (CAS no. 154702-15-5)*
- Terephthalylidene dicamphor sulfonic acid (CAS no. 92761-26-7)
- 4-Methylbenzylidene camphor (4-MBC) (CAS no. 36861-47-9)
- Benzophenone-12 (CAS No. 1843-05-6) (only the calculation of aggregated MOS)
- Benzophenone-1 (BP-1) (CAS no. 131-56-6) (only the calculation of the aggregated MOS)

The first-mentioned UV filters of the above are the UV filters that are used most on the Danish market, both in sunscreens and other cosmetic products. As an example, butyl methoxydibenzoyl-methane was found in 119 of the 291 products examined as part of the shop survey; of these 119 products, 75 were sunscreens. Titanium dioxide was found in 91 products, including 63 sunscreens. BP-1 and BP-12 are not allowed for use as UV filters in cosmetic products, but BP-1 was found as a UV absorber in 5 nail polishes, whereas BP-12 was not found in the shop survey of cosmetic products (11 stores).

- For one UV filter data was incomplete, and a risk calculation was not possible:
  - Drometrizol trisiloxane (CAS No. 155633-54-8)

- Based on the available data, the risk calculations for one UV filter indicates that use of the filter in sunscreens at the maximum allowed concentration may involve a certain risk, but not the scenario with aggregate exposure to various cosmetic products other than sunscreens:
  - Benzophenone-3 (BP3) (CAS No. 131-57-7)

BP-3 is allowed in concentrations of up to 10% in sunscreen products. However, in the scientific opinion of the SCCS, BP-3 is considered safe to use in concentrations of up to 6%, which is the concentration of the UV filter the industry is expected to use. BP-3 was found in 4 sunscreens on the Danish market.

- Based on the available data, the risk calculations for three UV filters indicate that there may be a risk when the filters are used in sunscreens at the maximum allowed concentration, and in the scenario with aggregate exposure to various cosmetic products other than sunscreens:
  - Octocrylene (OC) (CAS No. 6197-30-4)
  - 2-Ethylhexyl-4- (dimethylamino) benzoate (OD-PABA) (CAS No. 21245-02-3)
  - Isoamyl p-methoxycinnamate (CAS no. 71617-10-2)

- For a single UV absorber, the scenario with aggregate exposure to various cosmetic products other than to sunscreens indicates risk:
  - Benzophenone (BP) (CAS No. 119-61-9) (only the calculation of aggregated MOS)

The available data for the latter four substances are inadequate, and the risk assessments are therefore not conclusive. These UV filters may warrant further investigations, especially if there are sources of exposure other than cosmetics. BP is not approved as a UV filter and should not be used as such in sunscreen products. BP was not found in cosmetic products in the shop survey.

- Based on the available data, the risk calculations for two UV filters indicate that there may be a risk when the filters are used in sunscreens at the maximum allowed concentrations and applied at a rate of 36 g per day, but not at 18 g per day :
  - Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3)
  - Homosalate (HMS) (CAS no. 118-56-9)

The risk assessment methodology used by SCCS did not demonstrate a risk using the above two UV filters. However, in this report an additional scenario involving application of 36 grams of sunscreen per day has been included (at the request of the Environmental Protection Agency and as an addition to the conventional method recommended by SCCS), as there is currently a lack of knowledge regarding the importance of the thickness of the applied layer of sunscreen for dermal absorption.

In the risk assessments the possible endocrine disrupting properties of some of the substances are not considered, introducing an additional uncertainty with respect to the risk assessments, as there is still no consensus as to whether a lower limit for the effects of endocrine disrupters can be established.

When some of the risk calculations indicate that the approved UV filters present a hazard under certain conditions, although these are considered safe to use by SCCS in the maximum allowed concentrations, it may be due to fact that the assessments made in the present study, have the character of a screening based on a less complete data set. Additional data which could qualify a refinement of the risk assessment and increase the safety margin have not been obtained. Critical effects associated with the NOAEL values used in the MOS calculation are shown in . It may also be a result of new data which have become available after the UV filters have been assessed and approved by the SCCS.

The risk associated with exposure to sources other than cosmetics are not quantified due to lack of data. However, it is estimated on the basis of information about typical content of UV filters and absorbers in product types other than cosmetics, and typical use patterns for these products, that this exposure will only contribute a fraction of the exposure estimated for cosmetics. The substances are normally used in much lower concentrations than the concentrations used in cosmetics, typically about 1% or less, and the products are used with a much lower frequency, and are not intended for application directly to the skin. Use of the substances in mixtures as paints and other coatings, which may cause direct exposure during application and exposure via migration from articles and treated surfaces, along with exposure through drinking water and the environment, is not expected not to exceed 10% of the exposure to substances in cosmetics for the individual substances.

Data gaps

Identification of data deficiencies, which was one of the project purposes, is reported separately for all project focus areas in Chapter 7. The main shortcomings, in order to be able to answer some of the overarching questions considered in this project, involve lack of detailed knowledge of the different sources of exposure, the extent of the exposure from sources other than cosmetics, and the likelihood of exposure constituting a problem. In this respect, the uncertainty regarding the importance of endocrine disrupting effects is a significant data gap. In addition, there is a lack of knowledge about the occurrence of the substances in the Danish aquatic environment and biota, and possibly in drinking water. Currently this information is only available from other countries.

Development of exposure scenarios and analysis of the migration of some of the UV filters from various consumer products, such as coated wood products and furniture, could contribute with knowledge about the extent to which the substances can be expected to migrate from these products and give rise to either direct exposure by contact with the materials or other exposure in the indoor environment, for example via dust. It would also be of interest to examine the presence in the environment of certain UV-protective substances that are not included in cosmetics. The findings could contribute to strengthening the assessments of exposure and risk associated with the use substances in products other than cosmetics.

1. Background and introduction

1.1 Background

UV-protective substances are used to prevent the harmful effects of UV radiation on different materials and on human skin. The substances are added to cosmetics and a variety of materials, which are included in various mixtures and articles. They appear in chemical products for surface treatment of materials and in articles such as outdoor textiles, and in leather and wood products. The substances are used in order to achieve UV-protection of the product itself and / or the underlying material.

The EU Cosmetics Regulation[1] defines UV filters as follows:

> "UV-filters« means substances which are exclusively or mainly intended to protect the skin against certain UV radiation by absorbing, reflecting or scattering UV radiation."

UV filters in cosmetics must be approved, and only the filters that appear on Cosmetics Regulation Annex VI must be used for that purpose in cosmetics.

UV absorbers are not defined in the EU Cosmetics Regulation. In the Danish EPA dictionary[2] which contains explanations to some of the words and terms used in relation to cosmetic products, the following explanation of UV absorbers is provided (translated from Danish):

> "UV absorbers« are substances which absorb UV light in a product, thus reducing the degradation of the product which may result from the influence of sunlight. The difference between a UV absorber and a UV filter is that the UV absorber only protects the product from sunlight - not the user. Some UV absorbers may also function as UV filters."

UV absorbers used in cosmetics do not require special approval, and are not limited by a list of named substances. However, a safety assessment must be conducted for UV absorbers as well as other ingredients in cosmetic products.

CosIng (Cosmetic Ingredients Database) is the European Commission's database of cosmetic ingredients. CosIng contains both historical and new data from the period since the adoption of the former cosmetics directive in 1976. Not all substances in the database are used in cosmetics and are not necessarily allowed for use in cosmetic products. The database is searchable and in addition to the substance list it contains information on, among others, regulations and published scientific evaluations. For example, if you search for the function "absorbent", a list of 159 substances appears. These are substances which have been registered for that application over the years.

In addition to the 27[3] named substances (Annex VI to the Cosmetics Regulation) approved for use as UV filters in cosmetics (see Appendix 1), and the UV absorbers, which are listed in Cosing, there

[1] Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetic products
[2] http://www.mst.dk/Borger/Temaer/PersonligPleje/Tvaergaaende_emner/02100000.htm

may be other UV filters and UV absorbers used in a variety of other product and material types. No immediate overview exists of which substances are in use, their health and environmental properties, the type of consumer products in which they are used, or the exposure resulting from their use, is available.

Examples of materials and products containing UV filters include:

- Cosmetics (filters protect the skin)
- Food packaging, for example PET bottles (to protect the contents)
- Textiles and clothing (protects the skin)
- Coatings, paints, wood oils (protects the underlying wood or other materials)
- Cleaning and care products (e.g. for leather in order to counteract fading)
- Contact lenses and sunglasses (protects the eyes)
- Photographic equipment (enhanced imaging)
- UV protection in films and coatings (e.g. to protect works of art and furniture).

Examples of materials and products that contain UV absorbers include:

- Cosmetics (absorbers protect the product)
- Polymers (PVC, ABS, polyolefins, etc.) to be used in products that are exposed to UV radiation. Examples are plastics used for garden furniture, car interiors, children's toys for outdoor use and outdoor textiles.
- Electronics
- Paints, varnishes, sealants, adhesives, fillers, etc. used for outdoor applications
- Pigments and dyes for various applications, for example in textiles
- Printing inks
- Fittings for drinking water supply
- Textiles and clothing (protects clothes).

Both uses as UV filters and UV absorbers may, depending on the product types, result in exposure of consumers. Recent studies have given rise to increased safety concerns associated with some of the UV filters used in sunscreens and other cosmetic products, and exposure associated with their use in other product types. Several studies have demonstrated the presence of UV filters in the environment, the accumulation of lipophilic UV filters in biota and presence in breast milk and urine of children in the winter months, when they are not expected to be exposed to sun products with UV protection (Krause et al. , 2012; Schlumpf et al., 2010). One of the most used UV absorbers, benzophenone-3 (BP-3), has been found in 96% of urine specimens tested in the United States and several UV-filters have been found in 85% of Swiss samples of human milk (Calafat et al., 2008; Krause et al., 2012). BP-3 is also found in urine samples from children and adults in Denmark.

Adverse effects observed in laboratory animals exposed to UV filters include reproductive / developmental toxicity, and disruption of the hypothalamic-pituitary-thyroid axis (HPT). Few studies have examined the potential adverse effects in humans exposed to UV filters. Much focus has recently been on the potential endocrine disrupting effects of UV filters, which have been rated in the reports: "Evaluation of 22 SIN list substances according to the Danish proposal on criteria for endocrine disruptors" (Hass et al., 2012) and "Assessment of the endocrine disrupting potential of 23 UV filters" (Axelstad et al., 2013).

Some of the major concerns associated with the use of UV filters and UV absorbers are summarized in the box below.

[3] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted and the list therefore comprise 26 named substances as of August 2015.

Concerns with respects to use and effects of UV filters

UV filters are permitted in relatively high concentrations in cosmetic products (up to between 2 and 25%);

Some UV filters (as defined by the Cosmetic Regulations) are also used as UV absorbers in cosmetics;

UV filters/absorbers are used in many other types of products than cosmetics and are widespread in society;

Laboratory studies have shown that some UV filters have endocrine disrupting properties;

UV filters have been detected in ecosystems, fish and marine mammals (e.g. octocrylene in dolphins);

UV filters have been detected as residues in human milk;

Human biomonitoring studies in Denmark have detected UV filters in the urine of children (e.g. benzophenone-3) in the winter months. The results indicate that there is exposure occurring from sources other than sunscreen products, as benzophenone-3 is rapidly metabolised and excreted from the body;

Use in cosmetics and many other consumer products results in exposure of risk groups such as women of childbearing age, pregnant women and children.

(Gago-Ferrero et al., 2013; Krause et al., 2012)

1.2 Purpose of the project

The overall aim of the project is to map the occurrence of UV filters and UV absorbers in cosmetics and other products that may lead to exposure of consumers. The project addresses both the substances which, according to the EU Cosmetics Regulation, are approved as UV filters, and other UV filters and UV absorbers identified in the survey.

Based on the survey and the existing, available knowledge, the environmental and health effects of selected UV filters and UV absorbers are assessed, as well as the possible consumer exposure from different sources and the associated risk.

The project aims to identify areas where knowledge is lacking, as well as to identify substances which currently raise concern for the health of consumers and/or the environment, based on a common overall approach.

The overall questions to be answered in connection with the project are the following:

- Which UV filters and UV absorbers are used and where?
- What type of UV rays do they protect against?
- To what extent are consumers exposed?
- What are the applications of the UV filters and UV absorbers found in human biomonitoring studies and in the environment?
- Do the substances have unwanted health effects other than potential endocrine disrupting effects?
- Are the substances problematic in the environment?
- Is there a risk to consumers' health?

In answering the above questions, any missing data which would help to qualify the answers are also identified.

It will also be noted as to which filters and absorbers are sufficiently well documented and can be considered safe to use.

1.3 Possible endocrine disrupting effects of UV filters

The possible endocrine disrupting effects were recently assessed by the Danish Centre on Endocrine Disrupters (CEHOS) in another context (Hass et al., 2012 and Axelstad et al., 2013). These assessments are described in relation to the risk assessment of the substances, and the importance of the possible endocrine disrupting effects is addressed qualitatively in the relevant risk assessments.

The risk of possible endocrine disruption is not calculated quantitatively in the risk assessments. This is partly because none of the substances are identified as endocrine disruptors (there are no internationally accepted criteria for identification of endocrine disrupters) and partly because none of the substances are identified under REACH Article 57 (f), where the identification is done case by case. Furthermore, there is no consensus regarding whether a lower limit for the effects of endocrine disruptors can reasonably be set.

If a substance is suspected of being an endocrine disruptor, it is mentioned in relation to the hazard assessment whether this suspicion is being investigated. As an example, many UV filters are undergoing substance evaluation under REACH (the CoRAP list), meaning that all available data will be assessed by a Member State in the year indicated on the list. After that the Member States will decide together whether, on the basis of the data, [i)] there is no need for further action, [ii)] if the registrant is requested to carry out further testing, or [iii)] if there is a need to take further action to regulate the substance (e.g. identification as endocrine disrupters under Article 57 (f) and nomination to the candidate list).

1.4 UV filters and UV absorbers covered by the project

UV filters and UV absorbers are frequently added to cosmetics and plastic materials in particular, with the aim to protect either the skin or the materials against the harmful effects of UV radiation from the sun.

UV filters and UV absorbers that are covered by this investigation are as follows:

Cosmetics: UV filters covered by Annex VI of the Cosmetics Regulation and substances used as UV absorbers. The Cosmetics Regulation Annex VI includes 27[4] approved substances. Some of these substances may also be added as absorbers for the protection of the product. A list of used and approved UV absorbers does not exist, and this study therefore uses the CosIng database as starting point with regard to absorbers.

Substances in the Cosmetics Regulation Annex VI are shown in this report's Appendix 1 and substances listed in the European Commission CosIng database with the function "absorbent" are

[4] 26 as of 28 July 2015. According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted.

shown in the report in Appendix 3. Not all substances on this list are used in cosmetics.

Other products and matrices: Substances added as UV filters or UV absorbers to other products. UV absorbers are described as UV stabilizers in some parts of the literature, which is a broader term that also covers types of substances that provide UV protection for products/materials by mechanisms other than UV absorption.

In section 1.5 a description of the mechanisms of UV filters and substances that can be characterised as UV absorbers and which are covered by the project is provided.

In Appendix 1 the list of UV filters allowed in cosmetic products is shown. In Appendix 2 information about UV filters and UV absorbers obtained from Internet sources is presented. In Appendix 3 the list of substances characterised as "absorbents" in the EU CosIng database and their registration status under REACH is presented. Appendix 4 shows a list of UV filters and UV absorbers identified as part of the survey.

1.5 UV filters and UV absorbers - function and mechanism of action

The purpose of adding UV filters to the products and materials is to protect the underlying material from damaging ultraviolet radiation. In the case of cosmetics and textiles, it is the skin to be protected, and in the case of for example food contact materials, it is the food that must be protected.

UV absorbers are as mentioned a subset of UV stabilizers that are added or applied to a variety of products and materials, in order to prevent that the materials are degraded by UV radiation of different wavelengths. UV radiation is shortwave radiation with wavelengths from about 100 to 400 nanometers (nm). Ultraviolet radiation is divided into three types: UVA, UVB and UVC radiation. The radiation that reaches the Earth contains UVA and UVB radiation, while UVC radiation is absorbed by the ozone layer and atmospheric oxygen (KOKO, 2010).

Like other light, ultraviolet radiation consists of photons[5] which are quantized energy packets of electromagnetic radiation - often denoted by the Greek letter gamma (γ). The shorter the wavelength, the higher the energy of the photons. This energy is released when UV radiation is absorbed in a material; for example, the skin or the applied UV absorbent.

Both UVA and UVB rays can damage the skin. UVA rays can penetrate deep into the skin, where they together with UVB rays causing tanning of the skin, but at the same time contributing to aging of the skin and the development of skin cancer. UVB rays have shorter wavelengths and penetrate less deeply into the skin, but can still cause sunburn and skin cancer. Both UVA and UVB rays can cause solar eczema, but most people are sensitive to UVA rays (WHO, 2014).

The effect of UV radiation from both sunlight and artificial light on colored textiles is mainly yellowing and bleaching. The UV rays transform the water in the textiles to hydrogen peroxide (a common bleach) through a complex process that leads to fading of the dyes. High-energy photons of light that are typically found in the ultraviolet or violet spectrum may destroy the bonds in the chromophores (a chromophore is the part of a molecule that is responsible for its color), and leave the material colorless. Prolonged exposure to UV light and visible light, therefore, often leads to widespread discoloration. Ultraviolet light is the invisible high-energy portion of the spectrum, able

[5] Light consists of photons. A photon is an elementary particle with a pulse equal to its energy divided by the velocity of light; according to the theory of relativity has photon therefore rest mass of zero. (Gyldendals encyclopedia: http://www.denstoredanske.dk/) (in Danish).

to cause the most damage within the shortest period of time. Yellowing of e.g. wool was shown to be caused particularly by wavelengths in the UVA region (340 -420 nm) (NaturaLux, 2014).

In plastics, absorbed UV energy can result in excitation of electrons, which in turn generates reactive free radicals, which may contribute to breakdown of the materials. Some types of plastics cannot absorb UV radiation. Instead, the catalytic residues and other impurities in the plastic often act as receptors, which nevertheless lead to degradation. Small amounts of these impurities are sufficient for degradation to occur, and are sufficient to e.g. make the colors in polycarbonate unstable. In the presence of oxygen, the free radicals will result in the plastic becoming brittle. This process is often called photo-oxidation. As an example, window frames of PVC (polyvinyl chloride) exposed to sunlight become discolored and lose strength and elasticity, and a variety of other chemical changes may also occur if no UV stabilisers are added (NaturaLux, 2014).

The different types of UV filters and UV absorbers are described briefly in the following.

1.5.1 UV filters

UV filters can largely be divided into two types: chemical (organic) and physical (inorganic or mineral) filters.

The chemical filters absorb ultraviolet light and convert it into a small amount of heat. Chemical filters can protect in both the UVA and UVB ranges, but typically have a primary area of protection, and then provide minor, additional protection in another area. Chemical filters are the most commonly used UV filters, but are supplemented by physical filters in many products in order to obtain the desired protection (Lautenschläger, 2010).

If a molecule in the UV filter absorbs the energy of UV light in the form of photons, it will move from the ground state with the lowest energy to an excited state of higher energy. This state should only be transient, as there will otherwise be a high probability of formation of free radicals in place of thermal energy. While natural filters as melanin and nucleic acids convert the radiation to thermal energy (heat) by about 100 percent efficiency, chemical filters are less effective. The efficiency of, for example, 2-ethylhexyl 4-methoxycinnamate is about 80%, while the efficiency of other UV filters is often less than 50% (Lautenschläger, 2010).

Physical filters can reflect and scatter the UV light depending on the size of the particles, and they protect against both UVA and UVB radiation. Titanium dioxide (TiO_2) is a physical UV filter used in many sunscreens. It is also used in the nano form, as it increases the transparency of the sunscreen. Titanium dioxide is currently the only approved inorganic filter for cosmetics. Zinc oxide (ZnO) has been under assessment by the EU's Scientific Committee on Consumer Safety (SCCS, the Scientific Committee for Consumer Safety) and is expected to be approved as a UV-filter in cosmetics in both macro- and nano forms.

1.5.2 UV absorbers

UV absorbers belong to the group of UV stabilisers. UV stabilisers can be divided into three categories, based on their mechanisms of action (Ye & King, 2006):

- Substances which absorb UV radiation (benzophenones, benzotriazoles, salicylates, and the like.)
- Substances which are capable of transforming the excited state energy induced in the material by the UV radiation and dissipate that energy via low-frequency energy (quenchers: mainly metal complexes).
- Substances which react with free radicals generated by UV-induced degradation of hydroperoxides (scavengers: for example, anti-oxidants and hindered amines - HALS).

UV absorbers are generally very light-stable agents acting at different wavelengths, and preventing the degradation of the matrix is they arecontained in by transforming the UV radiation into heat. The amount of UV radiation absorbed follows the Beer-Lambert law, which shows the ratio between the light intensity before absorption and light intensity after absorption. This ratio is expressed as a function of the material thickness, and the concentration of the absorber:

Beer-Lambert's equation: $[A] = [e] \cdot [B] \cdot [C]$

where [A] is absorbance, [e] is the absorption coefficient, [B] is the path length of the light, and [C] is the concentration of the absorbing species (Ye & King, 2006).

To function properly the material needs to have a certain thickness and UV absorbers therefore provide only limited protection of e.g. fibers and film (Zweifel et al., 2009).

UV absorbers are normally added in relatively low concentrations, typically 0.1 -0.5% by weight of the material.

2. Survey of consumer products with UV filters and UV absorbers and monitoring data

2.1 Survey methodology

2.1.1 Literature search

As a starting point for the identification of consumer products containing UV filters and UV absorbers, a comprehensive literature search has been conducted. The search was intended partly to identify the substances that are used as UV filters and UV absorbers and partly to identify the materials and products in which the substances are used. The information has subsequently formed the basis for contact with relevant market players in Denmark.

The initial data search on the internet included entries in the encyclopaedia of Kirk-Othmer and Ulmann's and in handbooks on relevant materials such as plastics and textiles. Information searches on UV-protecting products/articles and commonly used UV filters and UV absorbers in the specific product types from technical data sheets have likewise been conducted.

UV filters that have been approved for use in cosmetics in the EU were identified via Annex VI in the Cosmetics Regulation (EUR-Lex, consolidated legislation). Possible UV absorbers were identified via the CosIng database (October 2013). The database contains an option to search for substances based on their function. However, not all substances that appear in the database are used in cosmetics.

UV filters and UV absorbers identified by searching the internet[6] via the known suppliers' websites were subsequently crosschecked against the EU ESIS database (now taken over by the European Chemicals Agency (ECHA)) and ECHA's databases on chemical information in order to determine

a) whether the substance has been registered under the REACH Regulation,
b) whether there are other manufacturers or importers of these substances in the EU, and
c) at which tonnage interval the substance is registered (if relevant), or whether the substance is a substance with a low production volume (LPV) or a high production volume (HPV) in the EU ESIS database.

The results are shown in Appendix 2.

In addition it was investigated as to whether various other authorities in Denmark and other European countries have conducted any surveys of UV-protective substances or whether they have published other relevant information in that field. In that connection, searches on the following websites have been conducted:

[6] Search conducted in November 2013

- Environmental Protection Agency in Denmark (www.mst.dk)
- Nature Agency in Denmark (www.nst.dk)
- KemI in Sweden (www.kemi.se)
- Environment Agency in Norway (www.miljodirektoratet.no)
- ANSES in France (www.anses.fr)
- RIVM in the Netherlands (www.rivm.nl)
- The Environment Agency in the UK (www.environment-agency.gov.uk)
- US EPA (www.epa.gov).

Finally, searches have been made on the following organisations websites:
- The Consumer Council/Tænk (www.taenk.dk)
- Information Centre for Environment and Health (www.forbrugerkemi.dk) (last updated in November 2013)
- ChemSec - International Chemical Secretariat (www.chemsec.org).

2.1.2 Data collection from market players

In order to obtain information about UV filters and UV absorbers in consumer products on the Danish market, contact has been made with a number of relevant trade associations and companies identified based on the initial data search. The companies have covered suppliers of raw materials, compounders (manufacturers of plastic compounds) and suppliers of consumer products. In addition to the specific questions regarding the use of filters and absorbers, all contacts were also asked which other companies and organisations the respondent would suggest contacting. Furthermore, contact has been made with laboratories performing chemical analysis of contents of various products, for example of UV filters and UV absorbers.

Suppliers of raw materials and compounders

In order to get an overview of which raw materials with UV filters and UV absorbers are available on the European market, searches for information about UV filters and UV absorbers on the known suppliers' websites have been conducted, including:
- BASF (Ciba was acquired by BASF in 2009)
- Addivant (SK Capital acquired Chemtura's "Antioxidant and UV Stabilizer Solutions" business in 2013 and now operates under the name Addivant)
- Clariant (The"Pigments and additives" division changed the tradename for some of their products in 2007/2008). The UV stabilizer Sandavor® was renamed Hostavin®.

Additionally, the following compounders were contacted in order to obtain information on the addition of UV filters and UV absorbers for plastics:
- Nordic Plastic Service
- PolyOn
- Controlled Polymers
- Synthetic Chemistry Scandinavia (Kunststof-kemi Skandinavia).

Trade associations

The following trade associations have been contacted:
- Wear (the trade association for the textile and fashion industry)
- DM&T, Danish Fashion and Textile (trade association for the textile and fashion industry)
- SPT (The Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries)
- The Danish Plastic Federation
- Danish Chamber of Commerce (Dansk Erhverv)
- DFL – The Danish Paints and Adhesives Industry
- TIETOY - the trade association for the European toy industry.

In some cases, the trade associations sent the query out to their members, either directly or via a newsletter on their website. In other cases, the associations referred directly to their member companies for gathering more information. The Danish Plastic Federation has contributed information on compound suppliers, but has not been able to contribute detailed information about themselves.

Manufactures and distributors

A large number of manufacturers and distributors of consumer products have been contacted via telephone and/or mail. The selection of companies has typically been conducted with the purpose of covering a representative market share for a given product group in Denmark. In some cases, the companies were contacted because they had a specific product in their assortment, in which UV filters or absorbers were used. The contacted companies are shown in Table 1.

Special focus was directed towards UV filters in cosmetic products. To complement the information received from the contacted companies, 10 different shops and a pharmacy with sale of cosmetic products were visited. On the basis of the declaration of ingredients, the presence of UV filters and UV absorbers was identified for a variety of product types with a potential content of these substances.

The shops visited are also shown in Table 1. It is assumed that the selected shops provide a representative picture of the cosmetic products that are available on the Danish retail market.

With regard to textiles, furniture and interior textiles retailers, clothing stores, outdoor retailers, awnings shops and children's clothing shops were contacted, as well as a company which manufactures fleece clothing from recycled plastic from bottles.

TABLE 1
CONTACTED MANUFACTURES AND DISTRIBUTORS OF CONSUMER PRODUCTS

Contacted manufacturers and distributors	
Cosmetics, contact per phone/mail	Cosmetics, shop visit
COOP, Dermapharm, Riemann, Matas A/S, L'Oréal International, Beiersdorf	Føtex, Kvickly, Netto, Lidl, Irma, Rema 1000, Magasin, Matas, TIGER, Helsemin and a pharmacy
Textiles	
Gabriel, Kvadrat tekstiler, IKEA, Joha, H&M Hennes & Mauritz, Bestseller A/S, COOP, Ønskebørn, DaneFæ, Patagonia, Fjällraven, Spejdersport, Nirwax, CPHDK Aps, Skovtrup LTD solsejl, Solsejlkompagniet ApS, Coolaroo	
Plastic and polymer products, including toys	
Bilka, Jysk, Toyota, Volkswagen, LEGO, COOP, BR legetøj, Legepladsbutikken, Dantoy, Polyfix, Little Tikes, Synoptik, Johnson and Johnson, Alcon, Coopervision, Sauflon, Rodenstock, Hoya, Apple, HP, Nordic Plastic Service, Controlled Polymers, PolyOne, Clariant, Kunststof-kemi Skandinavia	
Other uses	
Carlsberg, Royal Unibrew, COOP, analyselaboratorier, Sun Chemicals, Nopa A/S, Danlind A/S. Companies contacted via the trade association DFL – The Danish Paints and Adhesives Industry, which provided the overall responses.	

Laboratories

Two research institutes were also contacted in order to obtain information on experience with findings of UV filters and UV absorbers in textiles and UV filters in food packaging.

2.2 UV filters and UV absorbers from raw material suppliers

The results from the Internet search on suppliers' product information are summarized in the following sections. More detailed information is shown in Appendix 2.

2.2.1 BASF

The list of UV filters and UV absorbers from BASF are shown in Table 2. The information is obtained by searching on BASF's website[7] in the "Product finder" with the search terms "UV filters" and "UV absorbers".

TABLE 2
LIST OF UV ABSORBERS AND UV FILTRES FROM BASF

Product line	Description	Field of application
Carboprotect™	XYMARA CarboProtect is a solid UV Absorber developed for solvent borne coatings. Based on a red shifted hydroxyl-phenyl-benzotriazole chromophore, it is suited for coatings and substrates requiring strong protection both in UV A-range and in the near visible range.	Solvent-based surfacing coatings (e.g. Industry, automotive industry, building industry)
Chimasorb®	Chimassorb light stabilizing additives belong either to the UV-absorber chemical class of the 2-hydroxy-Benzophenone or to the group of hindered amines. Its performance in outdoor applications can be improved further by use in synergistic combination with a hindered amine light stabilizer (HALS) from BASFs Chimassorb or Tinuvin® range.	Solvent-based coatings, adhesives and sealants (e.g. Industry, automotive industry, construction industry, packaging, printing, plastics)
T-Lite™	UV filters (UVA + UVB)	Personal care
Tinosorb®	UV filters (UVA + UVB)	Personal care
Univul®	UV-filters (UVA + UVB, UVB)	Personal care and plastics
Z-COTE®	UV filters (UVA + UVB)	Personal care

2.2.2 ADDIVANT

Similarly, information from the company ADDIVANT has been sought. ADDIVANT distributes UV absorbers under the trade name LOWILITE. Information available from the website[8], found by searching under "solutions" and the function "UV absorbers" are shown in Table 3 together with information on the fields of application.

TABLE 3
LIST OF UV ABSORBERS FROM ADDIVANT

Product line	CAS No.	Chemical name (and synonym)	Field of application
UV absorbers of the benzophenone type (UVA)			
LOWILITE® 20 UV absorber	131-57-7	Benzophenone 3, BP-3	Polyester, polystyrene, polyvinyl chloride, and acrylic polymers.

[7] http://www.basf.dk/ecp1/Denmark/en/Product-finder/index
[8] http://www.addivant.com/solutions

Product line	CAS No.	Chemical name (and synonym)	Field of application
LOWILITE® 20S UV absorber	4065-45-6	Sulisobenzone, BP-4	Used in water-based cosmetics (sunscreens, shampoos, hair sprays and dyes), and in woolen fabrics, coatings, photographic film and lithographic plates.
LOWILITE® 22 UV absorber	1843-05-6	Benzophenone-12 (2-hydroxy-4-octoxy-phenyl)-phenyl-methaneone, BP-12	Effective in polyolefins, including polyethylene, low and high density, polypropylene, PVC, polyester, polystyrene and ABS.
LOWILITE® 24 UV absorber	131-56-6	Benzophenone-1, BP-1	Used in polystyrene, acrylic, unsaturated polyesters, thermoplastic rubbers, polyisoprene latex and alcohol based cosmetics.
UV absorbers of the benzotriazole type (UVA)			
LOWILITE® 55 UV absorber	2440-22-4	2-(2H-benzotriazol-2-yl)-p-cresol	Styrene, polyester and acrylic resin, PVC, polyacetal, adhesives, elastomers, polyurethane, epoxy materials and cellulose esters.
LOWILITE® 26 UV absorber	3896-11-5	Bumetrizole	Polyolefins, saturated polyester resin and coatings
LOWILITE® 27 UV absorber	3864-99-1	2-(2´-Hydroxy-3',5'-di-t-butylphenyl)-5-chlorobenzotriazole	Polyolefins, unsaturated polyester, acrylic and ABS
LOWILITE® 28 UV absorber	25973-55-1	2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol 2-(2´-Hydroxy-3',5'-di-t-amylphenyl) benzotriazole	Polyamides, polyesters or polyacetals, urethane or epoxy adhesives and sealants
LOWILITE® 29 UV absorber	3147-75-9	2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetra methylbutyl)phenol	Polyamides, polyesters or polyacetals, urethane or epoxy adhesives and sealants
LOWILITE® 234 UV absorber	70321-86-7	2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol 2-(2-Hydroxy-3,5-di(1,1-dimethyl benzyl)-2H-benzotriazole	High temperature plastic

2.2.3 CLARIANT

Clariant markets UV absorbers under the trade name Hostavin®. An overview of information about the products found on the company website[9] is presented in Table 4.

TABLE 4
UV ABSORBERS FROM CLARIANT

Product	CAS No.	Chemical name (and synonym)	Standard plastic	"Engineering" plastic
Hostavin 3310	25973-55-1	2-(2H-Benzotriazol-2-yl)-4,6-ditertpentylphenol 2-(2´-Hydroxy-3',5'-di-t-amylphenyl) benzotriazole	LDPE, HDPE, LLDPE, PP, PS, PS-HI, PVC, EVA	ABS/SAN, PET, PBT, POM, TPU
Hostavin 3326	3896-11-5	Bumetrizole	LDPE, HDPE, LLDPE, PP, PS, PS-HI, PVC, EVA	ABS/SAN, PET, PBT, POM, TPU
Hostavin ARO 8	1843-05-6	Benzophenone-12 (2-Hydroxy-4-octoxy-phenyl)-phenyl-methaneone	LDPE, HDPE, LLDPE, PP, PS, PS-HI, PVC, EVA	ABS/SAN, PET, PBT, POM, TPU

[9] https://www.clariant.com/en/Solutions/Product-Search

Product	CAS No.	Chemical name (and synonym)	Standard plastic	"Engineering" plastic
Hostavin B-CAP	6337-43-5	Tetraethyl 2,2'-(1,4-phenylendimethylidyn) bismalonat Diethyl 2-[[4-[2,2-bis(ethoxycarbonyl)ethenyl]phe-nyl] methyliden]propanedioat	LDPE, HDPE, LLDPE, PP, PS, PS-HI, PVC, EVA	ABS/SAN, PET, PBT, PMMA, PC, POM, TPU
Hostavin PR 25	7443-25-6	Dimethyl 2-[(4-methoxyphenyl)methyliden] propanedioat	PVC	ABS/SAN, PET, PBT, PMMA, PA, PC, POM, TPU
Hostavin VSU	23949-66-8	N-(2-ethoxyphenyl)-N'-(2-ethylphenyl)oxamide	PP, PVC	PET, PBT, PMMA, PA, PC, TPU

The UV absorbers Hostavin PR 25, ARO 8, VSU, 3310, 3326 and B-CAP® are highly absorbent relative to the sun's UV spectrum. The particular advantage of Hostavin PR 25, B-CAP and VSU is reported to be their lack of interaction with traces of metal ions. Such catalytically active impurities can be found in polymer matrices, for example from polymer catalyst residues, contact surfaces of equipment, metal impurities in filling materials etc.

Additionally, Clariant manufactures the product line CESA, which includes "master batches" containing UV stabilisers for cosmetics, PET packaging and other purposes.

2.3 Information on products containing UV-filters

It has generally been difficult to obtain information at the desired level of detail, i.e. information on chemical names and CAS numbers and information about specific products containing these substances and their concentration levels. There are several reasons for this, including lack of knowledge within the companies and thus a need to activate the supplier chain or the lack of resources to prioritize the issues. With regard to articles that are imported from countries outside the EU, it can be particularly challenging if there is no specific regulation on the article in question.

The main product areas and substances are described in the following section.

In December 2014, two UV absorbers used in plastics were included in the list of SVHC (the Candidate list) because of their PBT properties. The substances are thereby covered by the requirements for registration and notification of substances in articles according to Article 7 of the REACH Regulation[10]. This is the case for 2-benzotriazol-2-yl-4,6-di-tert-butyl phenol (UV-320) (CAS no. 3846-71-7) and 2- (2H-benzotriazol-2-yl) -4 , 6-ditertpentylphenol (UV-328) (CAS no. 25973-55-1).

2.3.1 Cosmetics

As previously mentioned, the use of UV filters in cosmetics is specifically regulated via a positive list of approved filters (Annex VI of the Cosmetics Regulation). Individual filters are effective at different wavelengths of ultraviolet light. Some offer protection against the full spectrum of UVA and/or UVB rays, and some only partially. Sun care products may therefore contain several different UV filters in order to provide a broad spectrum of protection.

[10] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC

The most commonly used filters according to Krause et al. (2012) are shown in Table 5. Only filters approved in the EU are shown.

TABLE 5
OVERVIEW OF THE MOST COMMONLY USED UV FILTERS IN COSMETICTS (KRAUSE ET AL., 2012)

UV-filters	CAS No.	Protection
Benzophenone-3	131-57-7	UVA, UVB
Octocrylene	6197-30-4	UVB
3-Benzylidenecamphor[11]	15087-24-8	UVB
3-(4-Methylbenzylidene)camphor	36861-47-9	UVB
Ethylhexyl methoxycinnamate	5466-77-3	UVB
Homosalate	118-56-9	UVB
Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	UVB
Titanium dioxide	13463-67-7	UVA, UVB

In addition to UV filters which protect the skin, cosmetic products may also contain UV absorbers which are added to protect the product. The CosIng database contains 159 substances in this category, of which not all are actually in use.

In a previous survey conducted for the Danish Environmental Protection Agency (Poulsen and Strandesen, 2011), the following UV filters and absorbers were found in 14 out of 89 products identified in Danish stores or online shops and marketed as "non-preserved" or "naturally preserved". The results from the survey are therefore not representative for cosmetics products in general, but rather contribute to the information about which UV filters and UV absorbers are used on the Danish market.

UV-absorbers:

- Camelia sinensis leaf extract (CAS No. 84650-60-2) - 5 products
- Zinc oxide (CAS No. 1314-13-2) - 3 products
- Benzyl salicylate (CAS No. 118-58-1) - 1 product

UV-filters:

- Titanium dioxide (CAS No. 13463-67-7) - 3 products
- Benzophenone-3 (CAS No. 131-57-7) - 1 product
- Ethylhexyl methoxycinnamate (CAS No. 5466-77-3) - 1 product

The report does not give information about the specific product types in which the substances are found. This information is, however, said to be available in an associated database.

Three out of the five contacted Danish companies have provided information about applications of UV filters and UV absorbers in cosmetics. The responses from the companies are shown in Table 6.

[11] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

TABLE 6
INFORMATION ON UV FILTERS AND UV ABSROBERS FROM COSMETICS COMPANIES

Company	Applied UV filters and UV absorbers	Comments
Company 1		The only products with UV filters are actual sun care products. Do not stock other cosmetic products (own production) containing UV filters. All sun products: sun lotions, sun sprays and sun sticks are labelled with the Nordic Eco-Label (the Swan), and therefore only the least environmentally harmful UV filters are used. Additionally, products labelled with the Nordic Eco-Label are not allowed to contain substances on the EU list of potential endocrine disruptors.
Company 2	Ethylhexyl triazone (CAS No. 88122-99-0) Titanium dioxide (non nano) (CAS No. 13463-67-7) Diethylhexyl butamido triazone (CAS No. 154702-15-5) Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7) Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)	Sun cream, facial cream. Only apply to filters accepted under the Nordic Eco-Label.
Company 3	Octocrylene (CAS No. 6197-30-4) Homosalate (CAS No. 118-56-9) Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)	Used in all sunscreens Is used in the amount providing the desired SPF (sun protection factor); from about 5% up to the specified maximum limit in the legislation.

In addition, the trade association SPT has asked selected companies about their use of UV filters. The consulted companies are companies that produce a relatively large proportion of the cosmetic products on the Danish Market. The responses categorised as "very frequently used," "less frequently used" and "barely used" UV filters, respectively, are shown in Table 7. Some substances are found in multiple columns because different companies using them have responded to the query.

TABLE 7
INFORMATION ON UV FILTERS AND UV ABSORBERS FROM TWO COSMETIC COMPANIES OBTAINED VIA SPT

Very frequently used	Less frequently used	Barely used
Response from company 1		
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7) Diethylhexyl butamido triazone (CAS No. 154702-15-5) Ethylhexyl triazone (CAS No. No. 88122-99-0) Bis-ethylhexyloxyphenol methoxytriazine (CAS No. 187393-00-6) Titanium dioxide (CAS No. 13463-67-7)	Phenylbenzimidazole sulphonic acid (CAS No. 27503-81-7) Octocrylene (CAS No. 6197-30-4) Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)	Ethylhexyl salicylate (CAS No. 118-60-5) Ethylhexyl triazone (CAS No. 88122-99-0) Titanium dioxide (nano) (CAS No. 13463-67-7) Ethylhexyl methoxycinnamate (CAS No. 5466-77-3)

Very frequently used	Less frequently used	Barely used
Response from company 2		
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7) Diethylhexyl butamido triazone (CAS No. 154702-15-5.) Ethylhexyl triazone (CAS No. 88122-99-0) Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6) Butyl methoxydibenzoylmethane (CAS No. 70356-09-1) Polysilicone-15 (CAS No. 207574-74-1)	-	-

Table 6 and Table 7 show that neither the directly contacted companies nor the businesses contacted by the SPT are using a number of those UV filters found in the biomonitoring studies (see Section 2.5.2). These UV filters would be expected to be clearly present in this study. This applies to benzophenone-3 (BP-3), 4-methylbenzylidene camphor (4-MBC), and ethylhexyl dimethyl PABA (OD-PABA). Homosalate (HMS) is used by a single company, and octocrylene (OC) is expressed as "less used" and ethylhexyl methoxycinnamate (OMC) as "barely used". BP-3, which is still being used as a UV filter in various product types, is also commonly observed in biomonitoring but seems to be replaced with other filters, especially in sun products (Johansen et al. (Ed.), 2011). The substance remains responsible for most positive photo-patch tests. Based on present study it cannot be excluded that that BP-3 is present on the market in cosmetics. Similarly, the substance may be found in other product types.

As part of the shop visits at the cosmetics retailers conducted during June/July 2014, 31 different UV filters/absorbers were found in 291 individual products, divided into 84 different brands. Sunscreens were in line with expectations: the product group where most UV filters/absorbers were found (approximately 24 different substances). Face cream and foundation also contained several different filters/absorbers (about 17 in each of the two product groups). The results are summarized in
Table 8. A wide range of different products were examined from the shops, with a focus on the products which would be expected to contain UV filters or absorbers. The total number of examined products has not been summed up, because the products were not randomly selected for the purpose of statistical determinations e.g. how great a proportion of a given product type on the market that contains the various UV filters and UV absorbers (this would either require that the market share of each brand is known or, rather, a much larger study with random sampling). The study, however, still gives a good indication of the types of products that may contain the substances and which substances are being used in most product types.

As seen in
Table 8, butyl methoxydibenzoylmethane (CAS no. 70356-09-1) was the UV filter found in most individual products: a total of 119 products (including 75 sunscreens). Table 8 and Table 9 indicate that the other substances which were found in more than 50 products were titanium dioxide (incl. the nano form) (CAS no. 13463-67-7) found in 91 products (including 63 sunscreens), benzyl salicylate (CAS no. 118-58-1) found in 87 products (including 17 sunscreens), ethylhexyl salicylate (CAS no. 118-60-5) found in 84 products (including 44 sunscreens), ethylhexyl triazone (CAS no. 88122-99-0) found in 73 products (of which 69 were sunscreens), ethylhexyl methoxycin-

hydrocinnamate (CAS no. 5466-77-3) found in 59 products (including 14 sunscreens), bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS no. 187393-00-6) found in 55 products (including 45 sunscreens) and diethyl hydroxybenzyol hexyl benzoate (CAS no. 302776-68-7) found in 53 products (including 46 sunscreens). For sunscreens alone (Table 9) where the exposure from cosmetic products is greatest, the most prevalent UV filters on the Danish market are butyl methoxydibenzoylmethane (70356-09-1) (75 sunscreens), ethylhexyl triazone (CAS no. 88122-99-0) (69 sunscreens), titanium dioxide incl. the nano form (13463-67-7) (63 sunscreens), octocrylene (6197-30-4) (53 sunscreens), diethyl hydroxybenzyol hexyl benzoate (CAS no. 302776-68-7) (46 sunscreens), bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS no. 187393-00-6) (45 sunscreens), diethylhexyl butamidpo triazone (154702-15-5) (45 sunscreens) and ethylhexyl salicylate (CAS no. 118-60-5) (44 sunscreens). As seen by comparing Table 6 and Table 7, there is a reasonably good correlation between shop survey results and the feedback from the consulted manufacturers about which UV filters and UV absorbers that are used most frequently.

The results are only partially consistent with the results of Krause et al. (2012) (see Table 5). According to Krause et al. (2012), benzophenone-3 (BP-3) is among the most used UV filters in cosmetics on markets other than the Danish market, along with 3-benzylidene (3-BC), 3- (4-methyl-benzylidene) camphor (4-MBC), 2-ethylhexyl 4-methoxycinnamate (OMC), homosalate (HMS), 2-ethylhexyl 4-dimethylaminobenzoate (OD-PABA) and 4-amino benzoic acid (PABA). This may partly be because the study does not reflect current usage, as it is from 2012, and partly due to the fact that the investigation was not carried out in Denmark.

The results of shop visits also showed that not all UV filters found in Danish biomonitoring studies are found in cosmetic products on the Danish market. 3-benzylidene (3-BC)[12] and 3- (4-methyl-benzylidene) camphor (4-MBC), which are mentioned as frequently used by Krause et al. (2012), were not found in any of the products in the survey. OMC was found in 59 products (including 14 sunscreens), OC was found in 76 products (including 53 sunscreens), HMS was found in 27 products (including 18 sunscreens), BP-3 was found in 17 products (including 4 sunscreens) and OD-PABA was detected in 2 products (including 1 sunscreen).

Among the 291 products, sun products sold as aerosol sprays were also identified. These products included the following UV filters:

- Octocrylene
- Butyl methoxy-dibenzoylmethane
- Ethylhexyl salicylate
- Bis-ethylhexyloxyphenol methoxyphenyl triazine
- Ethylhexyl methoxycinnamate
- Homosalate
- Drometrizol trisiloxane.

[12] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

TABLE 8
OVERVIEW OF UV FILTERS AND UV ABSORBERS USED IN COSMETICS ON THE DANISH MARKET ACCORDING TO A PRODUCT SCREENING IN 10 SELECTED DANISH SHOPS AND A PHARMACY.

UV filters/absorbers	CAS No.	Product group	Number of single products out of 291 products with UV filters or UV absorbers
Benzotriazolyl dodecyl p-cresol	125304-04-3	Face oil; Foundation	2
Benzophenone-1	131-56-6	Nail polish	5
Benzophenone-3	131-57-7	Face cream; Eau de toilette; Foundation; Hand cream; Lip balm; Sunscreen; Eye cream	17
Benzophenone-4	4065-45-6	Facial serum; Conditioner; Body Wash; Hand soap; Hair treatment; Shampoo	10
Benzyl salicylate	118-58-1	Face cream; Conditioner; Body lotion; Body oil; Body Wash; Cream; Deodorant; Eau de toilette; Foundation; Hand soap; Hair treatment/conditioner; Hair mousse; Hair oil; Makeup remover; Nail polish; Perfume; Powder; Cleaning tissues; Shampoo; Sun oil; Sun screen	87
Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	Face cream; Day cream; Foundation; Sun screen	55
Butyl methoxydibenzoylmethane	70356-09-1	Face cream; Body Wash; Cream; Day cream; Eau de toilette; Foundation; Hand cream; Lip balm; Makeup; Nail polish remover; Perfume; Sun oil; Sun screen	119
Camellia sinensis leaf extract	84650-60-2	Facial serum; Face cream; Body lotion; Body Wash; Foundation; Shampoo/conditioner; Skin tonic; Sun screen; Eye cream	17
Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	Face cream; Eau de toilette; Foundation Sun screen	53
Diethylhexyl butamido triazone	154702-15-5	Face cream; Sun screen	48
Drometrizole trisiloxane	155633-54-8	Makeup; Sun screen	27
Ethyl ferulate	4046-02-0	Sun screen	1
Ethylene/methacrylate copolymer	-	Foundation	1
Ethylhexyl dimethyl PABA	21245-02-3	Sun screen, Foundation	2
Ethylhexyl methoxycinnamate	5466-77-3	Face cream; Conditioner; Body Wash; Eau de toilette; Foundation; Hand cream; Hair treatment; Hair oil; Lip balm; Makeup; Perfume; Primer/cream; Shampoo/conditioner; Sun screen; Eye cream	59
Ethylhexyl salicylate	118-60-5	Face cream; Body Wash; Cream; Day cream; Eau de	84

UV filters/absorbers	CAS No.	Product group	Number of single products out of 291 products with UV filters or UV absorbers
		toilette; Foundation; Hand cream; Lip balm; Makeup; Perfume; Sun oil; Sun screen	
Ethylhexyl triazone	88122-99-0	Face cream; Sun oil; Sun screen	73
Homosalate	118-56-9	Face cream; Cream; Foundation; Lip balm; Makeup; Sun screen	27
Isoamyl p-methoxycinnamate	71617-10-2	Face cream; Sun screen	10
Menthyl salicylate	89-46-3	Mouthwash	1
Methylen bis-benzotriazolyl tetramethylbutylphenol (incl. the nano form)	103597-45-1	Face cream; Sun screen	12
Octocrylene	6197-30-4	Face cream; Foundation; Hand cream; Lip balm; Makeup; Nail polish remover; Sun oil; Sun screen	76
Phenylbenzimidazole sulphonic acid	27503-81-7	Day cream; Sun screen; Face cream; Hand cream	6
Polysilicone-15	207574-74-1	Sun screen	1
Terephthalylidene dicamphor sulfonic acid	92761-26-7 / 90457-82-2	Makeup; Sun screen	21
Titanium dioxide (incl. the nano form)	13463-67-7	Face cream; Foundation; Makeup; Powder; Sun screen; Hand cream	91
Triethoxy caprylylsilane	2943-75-1	Foundation; Makeup	3
Trimethoxy caprylylsilane	3069-40-7	Makeup, Sun screen	5
Tris (tetramethylhydroxypiperidinol) citrate	220410-74-2	Foundation	1
Vitis vinifera seed extract	84929-27-1	Sun screen	1
Zinc oxide	1314-13-2	Face cream; Face mask; Foundation; Sun screen	7

Several UV absorbers have functions other than to protect against UV light and can therefore be found in products where they are not added because of the UV-absorbing function. As an example, methyl salicylate (CAS No. 89-46-3) can be assumed to be added to mouthwash due to the "masking" function, which contributes to reduce or inhibit the basic odour or taste of the product (CosIng, 2014).

TABLE 9
OVERVIEW OF USED UV FILTERS AND UV ABSORBERS IN COSMETICS ON THE DANISH MARKET BY PRODUCT. NOTE THAT MANY OF THE PRODUCTS CONTAIN SEVERAL UV FILTERS/ABSORBERS WHY THE TOTAL AMOUNT OF SUBSTANCES FOR EACH PRODUCT CATEGORY IS LARGER THAN THE NUMBER OF PRODUCTS IN THE GIVEN CATEGORY.

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
Facial serum	1	Benzophenone-4	4065-45-6	F	1
		Camellia sinensis leaf extract	84650-60-2		1
Face cream	31	Benzophenone-3	131-57-7	F	5
		Benzyl salicylate	118-58-1		7
		Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	F	6
		Butyl methoxydibenzoylmethane	70356-09-1	F	20
		Camellia sinensis leaf extract	84650-60-2		1
		Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	F	3
		Diethylhexyl butamido triazone	154702-15-5	F	3
		Ethylhexyl methoxycinnamate	5466-77-3	F	10
		Ethylhexyl salicylate	118-60-5	F	16
		Ethylhexyl Triazone	88122-99-0	F	3
		Homosalate	118-56-9	F	4
		Isoamyl P-methoxycinnamate	71617-10-2	F	1
		Octocrylene	6197-30-4	F	12
		Phenylbenzimidazole sulfonic acid	27503-81-7	F	2
		Titanium dioxide (incl. the nano form)	13463-67-7	F	5
		Zinc oxide	1314-13-2		1
Face mask	1	Zinc oxide	1314-13-2		1
Face oil	1	Benzotriazyol dodecyl p-cresol	125304-04-3		1
Conditioner	4	Benzophenone-4	4065-45-6	F	1
		Benzyl salicylate	118-58-1		3
		Ethylhexyl methoxycinnamate	5466-77-3	F	2
Body lotion	6	Benzyl salicylate	118-58-1		3
		Camellia sinensis leaf extract	84650-60-2		2

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
Body oil	1	Benzyl salicylate	118-58-1		1
Body wash	10	Benzophenone-4	4065-45-6	F	4
		Benzyl salicylate	118-58-1		5
		Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Camellia sinensis leaf extract	84650-60-2		1
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
		Ethylhexyl salicylate	118-60-5	F	1
Cream	2	Benzyl salicylate	118-58-1		1
		Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Ethylhexyl salicylate	118-60-5	F	1
		Homosalate	118-56-9	F	1
Day cream	1	Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	F	1
		Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Ethylhexyl salicylate	118-60-5	F	1
		Phenylbenzimidazole sulfonic acid	27503-81-7	F	1
Deodorant	7	Benzyl salicylate	118-58-1		5
Eau de toilette	13	Benzophenone-3	131-57-7	F	3
		Benzyl salicylate	118-58-1		11
		Butyl methoxydibenzoylmethane	70356-09-1	F	7
		Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	F	2
		Ethylhexyl methoxycinnamate	5466-77-3	F	9
		Ethylhexyl salicylate	118-60-5	F	7
Foundation	29	Benzatriazyol dodecyl p-cresol	125304-04-3		1
		Benzophenone-3	131-57-7	F	2
		Benzyl salicylate	118-58-1		3
		Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	F	3
		Butyl methoxydibenzoylmethane	70356-09-1	F	4
		Camellia sinensis leaf extract	84650-60-2		3

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
		Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	F	2
		Ethylen/methacrylate	-		1
		Ethylhexyl Dimethyl PABA	21245-02-3	F	1
		Ethylhexyl methoxycinnamate	5466-77-3	F	9
		Ethylhexyl salicylate	118-60-5	F	5
		Homosalate	118-56-9	F	1
		Octocrylene	6197-30-4	F	4
		Titanium dioxide (incl. the nano form)	13463-67-7	F	7
		Triethoxy caprylylsilane	2943-75-1		2
		Tris (tetramethylhydroxypiperidinol) citrate	220410-74-2		1
		Zinc oxide	1314-13-2		1
Hand cream	4	Benzophenone-3	131-57-7	F	1
		Butyl methoxydibenzoylmethane	70356-09-1	F	2
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
		Ethylhexyl salicylate	118-60-5	F	2
		Octocrylene	6197-30-4	F	1
		Phenylbenzimidazole sulfonic acid	27503-81-7	F	1
		Titanium dioxide (incl. the nano form)	13463-67-7	F	1
Hand soap	4	Benzophenone-4	4065-45-6	F	1
		Benzyl salicylate	118-58-1		3
Hair treatment/conditioner	6	Benzophenone-4	4065-45-6	F	1
		Benzyl salicylate	118-58-1		6
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
Hair mousse	1	Benzyl salicylate	118-58-1		1
Hair oil	2	Benzyl salicylate	118-58-1		1
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
Lip balm	2	Benzophenone-3	131-57-7	F	1

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
		Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
		Ethylhexyl salicylate	118-60-5	F	1
		Homosalate	118-56-9	F	2
		Octocrylene	6197-30-4	F	1
Makeup	7	Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Drometrizole trisiloxane	155633-54-8	F	1
		Ethylhexyl methoxycinnamate	5466-77-3	F	3
		Ethylhexyl salicylate	118-60-5	F	2
		Homosalate	118-56-9	F	1
		Octocrylene	6197-30-4	F	3
		Terephthalylidene dicamphor sulfonic acid	92761-26-7	F	1
		Titanium dioxide (incl. the nano form)	13463-67-7	F	7
		Triethoxy caprylylsilane	2943-75-1		1
		Trimethoxy caprylylsilane	3069-40-7		1
Makeup remover	1	Benzyl salicylate	118-58-1		1
Mouthwash	1	Methyl salicylate	119-36-8		1
Nail polish	6	Benzophenone-1	131-56-6		5
		Benzyl salicylate	118-58-1		1
Nail polish remover	1	Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Octocrylene	6197-30-4	F	1
Perfume	5	Benzyl salicylate	118-58-1		4
		Butyl methoxydibenzoylmethane	70356-09-1	F	4
		Ethylhexyl methoxycinnamate	5466-77-3	F	4
		Ethylhexyl salicylate	118-60-5	F	3
Primer/cream	1	Ethylhexyl methoxycinnamate	5466-77-3	F	1
Powder	2	Benzyl salicylate	118-58-1		1
		Titanium dioxide	13463-67-7	F	1

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
Cleaning tissues	2	Benzyl salicylate	118-58-1		2
Shampoo	11	Benzyl salicylate	118-58-1		9
		Camellia sinensis leaf extract	84650-60-2		3
		Benzophenone-4	4065-45-6	F	2
Shampoo/conditioner	1	Camellia sinensis leaf extract	84650-60-2		1
		Ethylhexyl methoxycinnamate	5466-77-3	F	1
Skin tonic	1	Camellia sinensis leaf extract	84650-60-2		1
Sun oil	1	Benzyl salicylate	118-58-1		1
		Butyl methoxydibenzoylmethane	70356-09-1	F	1
		Ethylhexyl salicylate	118-60-5	F	1
		Ethylhexyl Triazone	88122-99-0	F	1
		Octocrylene	6197-30-4	F	1
Sun screen	126	Benzophenone-3	131-57-7	F	4
		Benzyl salicylate	118-58-1		17
		Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	F	45
		Butyl methoxydibenzoylmethane	70356-09-1	F	75
		Camellia sinensis leaf extract	84650-60-2		3
		Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	F	46
		Diethylhexyl Butamido Triazone	154702-15-5	F	45
		Drometrizol trisiloxane	155633-54-8	F	26
		Ethyl Ferulate	4046-02-0		1
		Ethylhexyl Dimethyl PABA	21245-02-3	F	1
		Ethylhexyl methoxycinnamate	5466-77-3	F	14
		Ethylhexyl salicylate	118-60-5	F	44
		Ethylhexyl Triazone	88122-99-0	F	69
		Homosalate	118-56-9	F	18
		Isoamyl P-methoxycinnamate	71617-10-2	F	9
		Methylen bis-benzotriazolyl tetramethylbutylphenol (incl. the	103597-45-1	F	11

Product	Number of products in the category	UV filters/absorbers	CAS No.	Approved UV filters, F	Number of single products out of 291 products with contents of certain UV filters or UV absorbers
		nano form)			
		Octocrylene	6197-30-4	F	53
		Phenylbenzimidazole sulphonic acid	27503-81-7	F	2
		Polysilicone-15	207574-74-1	F	1
		Terephthalylidene dicamphor sulfonic acid	92761-26-7	F	20
		Titanium dioxide (incl. the nano form)	13463-67-7	F	63
		Trimethoxy caprylylsilane	3069-40-7		4
		Vitis vinifera seed extract	84929-27-1		1
		Zinc oxide	1314-13-2		4
Eye cream	1	Benzophenone-3	131-57-7	F	1
		Camellia sinensis leaf extract	84650-60-2		1
		Ethylhexyl methoxycinnamate	5466-77-3	F	1

As shown in Table 9, approved UV filters were found in 23 of the 34 product categories shown in the table, and a total of 19 out of the 27[13] approved UV filters are represented in the investigated products. Thus, UV filters are present in many more product types than those immediately expected to contain UV protection, including eau de toilette, hand soap, perfume and nail polish remover. In addition, several products contain more than one UV filter. This may, as mentioned earlier, be due to the fact that these substances have functions other than to protect from UV light and can therefore be found in products where they are not added because of the UV protective function.

Rastogi (2002) examined the contents of 18 different approved chemical UV filters in 75 sun products on the Danish market to assess whether the products were in accordance with the current legislation. The results showed that all products complied with the maximum limits for the content of the substances. 81% of the products contained a total of 14 of the 18 substances examined. The others contained physical filters. Ethylhexyl methoxycinnamate (CAS No. 5466-77-3) and butyl methoxydibenzoylmethane (CAS No. 70356-09-1) were the most frequently occurring substances with 49.3% (37 products) and 44.0% (33 products) of the products, respectively. Benzophenone-3 occurred in 18.7% of the products and 4-Methylbenzylidene camphor (CAS No. 36861-47-9) and Octocrylene (CAS No. 6197-30-4) were found in 22.7% of the products.

Among the 5 chemical UV filters found in most products by Rastogi (2002), 4 of them are also found in sun care products (sunscreen and sun oil) in the present study. Ethylhexyl methoxycinnamate was found in 11% of the products, butyl methoxydibenzoylmethane in 59% of the products, BP-3 in 3.1% of the products and octocrylene in 42% of products with UV filters or UV absorbers.

[13] 26 as of 28 July 2015 according to Commission Regulation (EU) 2015/1298 of 28 July 2015

The results of the shop survey combined with information from the industry indicate that substances such as 3-BC[14] and 4-MBC are no longer used as UV filters in cosmetic products on the Danish market. According to the shop survey, OMC and OC are used in a number of cosmetic products/sun screens, although the industry indicates a minor use. HMS, BP-3 and OD-PABA are used to a lesser extent. The Danish Environmental Protection Agency concluded in 2001 a voluntary agreement with manufacturers/importers of sun screen products that 4-MBC was not allowed to be used in products for children under 12. The agreement is not legally binding. The explanatory statement was 4-MBC having an endocrine disrupting effect on the thyroid gland.

2.3.2 Textiles

The UV protection factor (UPF) in textiles is highly dependent on the chemical structure of the fibres, the presence of additives and the tightness of the weaving and knitting.

Fibers of cotton, silk, linen and hemp provide little protection against UV radiation, as the rays pass through the fibres without being absorbed to a great extent. Wool and polyester provide considerably higher protection SPF (sun protection factor) since the fibres will absorb UV radiation. Nylon lies in between these extremes. One factor that influences the ability of nylon- and polyester fibres to absorb light is the presence of titanium dioxide, which strongly reflects UV radiation. Acrylic fibres also have a good ability to absorb light (Dubrovski, 2010).

Many dyes absorb UV radiation as well as visible light. Cotton fabrics dyed in a deep shade can achieve a sun protection factor of 50 or higher solely because of the dye (Dubrovski, 2010). As fashion and comfort often dictate the use of light coloured textiles for clothing in the summer, the need arose for UV-absorbing substances that could be added to textile fibres in order to provide the desired sun protection, even in light tones of textile.

UV absorbers are therefore added to some textiles, either with the purpose of reducing permeability to UV radiation in order to protect the underlying skin or to protect the fabric against degradation.

It is believed that the following types of fabrics could possibly be treated with UV filters or UV absorbers:

- Clothing designed for outdoor use, including swimwear and sportswear (may include t-shirts, shirts, pants, socks and clothing for skiing, fishing, trekking, etc.)
- Other equipment for outdoor use, for example backpacks
- Clothes designed to avoid fading
- Textiles designed for outdoor use, including textiles for furniture (e.g. pillows), deck chairs, awnings, tents, etc.
- Textiles for cars and other means of transport
- Textiles for indoor use, with the purpose of avoiding fading (e.g. furniture, carpets, curtains, etc.).

Both chemical and physical UV filters are used in textiles. Zinc oxide is also used in the form of nanoparticles. Typical UV filters and UV absorbers used in textiles are presented in Table 10.

[14] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

TABLE 10
OVERVIEW OF THE MOST COMMONLY USED UV FILTERS AND UV ABSORBERS IN TEXTILES (BASED ON UV, 2011A)

Chemical name	CAS No.	Fibre	Type
2-Hydroxy-4-methoxy-5-sulfoBenzophenone	4065-45-6	Wool	Benzophenone
2-Hydroxyphenyl-s-triazines (group of substances)	-	Wool	Triazine
4-Aminophenyl-1H-benzimidazol-5-sulphonic acid	Not available	Cotton	Phenylbenzimidazol
Nano titanium dioxide	13463-67-7	Polyester	Screener

In the case of textiles, information about titanium dioxide and zinc oxide in UV-protective swimwear e.g. for children have been found via product information from the Internet.

A Danish textile company has stated that sulfonated benzotriazole derivative is used in furniture textiles, for example. The supplier of benzotriazole also supplies triazine for polyester fibres in the car industry.

A company manufacturing fleece clothing made of yarn from recycled plastic states that weaving tightness and colour usually determines the level of protection against sunlight. Dark colours absorb more light, including UV light, and thereby provide an increased protection. However, TiO2 may be added to the fibres of the yarn or colours, absorbing UV light but reflecting visible light. This may be used so that also lighter colours also provide good UV protection. The company was not aware if the recycled yarn itself contained UV protective substances.

Data from the literature further indicate that the typical UV absorbers used for textiles (including automotive textiles) include: 2-hydroxybenzophenone (CAS No. 117-99-7) (textile of cotton), Benzophenone-1 (CAS No. 131-56-6) (textile of polypropylene), and Benzophenone-6 (CAS No. 131-54-4) (textile of poly(m-phenylene-terephthalamide-fibres). Other absorbers mentioned are: 2-hydroxyphenylbenzotriazoles and 2-hydroxyphenyl-s-triazines. For polyester Tinovin 326 (Bumetrizole/ CAS No. 3896-11-5) and Uvinul D-49 (benzophenone 6, CAS No. 131-54-4) may be used (Fung and Hardcastle, 2001).

Additional responses regarding textiles are shown in Table 11. Of the 14 companies contacted, the majority answered the inquiries, but most of them could not provide the desired information.

TABLE 11
INFORMATION ON UV FILTERS AND UV ABSORBERS FROM TEXTILE COMPANIES AND THE DANISH TECHNOLOGICAL INSTITUTE.

Company	Used UV filters and absorbers	Comments
Company 1	CIBA 783 CIBA 788 (NU BASF Trade names)	Used in shade sails and umbrellas UV filters are included by 1-3%
Company 2	-	Do not use UV-filters
Company 3	No information	Internet Search on the company's website shows various products, including spray products, which can be used for UV protection of outdoor fabrics such as tents. Moreover, clothing with "UV protection UPF 30+" is sold from Fjällräven and others. It is however not clear whether UV filters are added to the fabric or if the protection is due to the weaving of the fabric.

Company	Used UV filters and absorbers	Comments
Company 4	No information	The company cannot disclose the specific chemicals. Sun protection agents to spray on tents and other equipment contain UVA and UVB protection.
Company 5	No information	The company does not believe that UV protection is used in their clothing textiles, either to protect consumers or to protect the textile. Only the weaving of the fabric provides the protection. The company do not have any high-tech clothing (especially outdoor clothing, which provides specific UV protection. The company acknowledges that there may be UV filters/absorbers in their outdoor fabrics, such as umbrellas and cushions for outdoor furniture.
Company 6	Benzotriazole: 0.5-1%, Triazine: 0.5-1% - both in polyester	Polyester fibres for the automobile industry
Technological Institute, Clothing and Textile (carry out the certification of UV-protective textiles)	-	The Institute states: UV filters are especially used in children's clothes, t-shirts and swimwear. The use in Denmark is probably limited, as the sun is not as powerful here. UV protection may be particularly relevant in outdoor furniture, cushions and umbrellas. Dyes also contribute to UV protection; the more dye, the more UV protection. Relevant product types: sunshades (awnings, sails for playgrounds), sun hats and swimwear. It is difficult to know which substances are being used because the textiles are not produced in Denmark, and Danish companies do not know either, because they buy their materials from abroad. TI estimates that companies adding UV filters typically will indicate that the fabric is UV protected.

2.3.3 Articles of plastics and other polymers, including toys

Many articles containing plastics and other polymers are designed for outdoor use and are thereby subject to degradation by UV light. Examples of products relevant for consumer use that are believed by the authors of this report to be treated with UV filters or UV absorbers include:

- Plastic furniture for outdoor use (e.g. garden furniture)
- Plastic furniture for indoor use including furniture covered with laminated fabrics (PVC, PU)
- Toys and play equipment for both indoor and outdoor use
- Air mattresses and sports equipment
- Tarpaulins and other items based on coated fabrics
- Geotextiles (weed fabric, paving fabrics, paint masking, acoustic products for stairs, root protection, boat tarpaulins etc.)
- Transparent roofing materials (for carports, conservatories, etc.).
- Doors and windows
- Skylights and ventilation parts
- Roofing membranes
- Garden hoses
- Agricultural film (for packing)
- Plastic/polymer parts in automobiles etc.
- Plastic parts for indoor use designed to avoid fading (e.g. floors, handles, electrical cables and wires, etc.)

- Enclosures for electrical and electronic equipment (household appliances, radio, TV and music equipment, PCs, mobile phones, tablets)
- Plastic accessories like sunglasses, bracelets and watchbands
- Plastic and rubber footwear (sandals, boots, etc.).
- Contact lenses
- Sealants (for buildings and other purposes)
- Panes, windscreens (stabilization of plastic films and sealants used in laminated glass and similar applications).

Substances used as UV filters and UV absorbers in plastics vary between different types of plastics and their actual uses. Some of the most important substances used in PVC are shown in Table 12 (UV, 2011b).

TABLE 12
UV FILTERS AND UV ABSORBERS USED IN PVC (UV, 2011B)

Chemical name	CAS No.	Chemical group
UVA protection		
Benzophenone-12	1843-05-6	Benzophenones
Benzophenone-3	131-57-7	Benzophenones
Benzophenone-8	131-53-3	Benzophenones
2 (2H- Benzotriazol -2-yl)-p- cresol	2440-22-4	Benzotriazoles
2- Benzotriazol- 2-yl- 4,6- di-tert- butylphenol	3846-71-7	Benzotriazoles
2 - (2H -Benzotriazol -2- yl) -4,6- di-tert- pentylphenol	25973-55-1	Benzotriazoles
Octrizole	3147-75-9	Benzotriazoles
2 - (2H- Benzotriazol -2-yl)-6 -dodecyl- 4-methylphenol, branched and linear	23328-53-2, 125304-04-3, 104487-30-1	Benzotriazoles
Reaction product of methyl-3 (3 - (2H -benzotriazol -2-yl)-5- t- -4-hydroxyphenyl -propionat / PEG 300; poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy-	104810-48-2, 104810-47-1; 25322-68-3	Benzotriazoles
2-Propen acid, 2-cyano-3,3-diphenyl-, ethyl ester	5232-99-5	Cyanoacrylates
N-(2- ethoxyphenyl) -N'-(2- ethylphenyl) oxamide; Dimethyl 2-[(4-methoxyphenyl)methyliden] propanedioate	23949-66-8, 7443-25-6	Oxalanalides, Malonates
Screeners (Screeners prevent light from penetrating deeply into the product)		
Carbon black	-	Inorganic
Titanium dioxide	13463-67-7	Inorganic
Zinc oxide	1314-13-2	Inorganic

The result from the company contacts with the industry's compounders and suppliers of the products are shown in Table 13. Two of the four contacted compounders were able to contribute information to the study. Distributors of plastic products, including furniture, toys, car parts and glasses/contact lenses could generally not obtain information, but referred to the suppliers and manufacturers of the products. Several European toy manufacturers have, via contact to the trade association TIE TOY, indicated that UV filters and UV absorbers also can occur in plastic toys for indoor use.

TABLE 13
INFORMATION ON UV FILTERS AND UV ABSORBERS IN PLASTIC- AND POLYMER PRODUCTS FROM MANUFACTURERS AND SUPPLIERS.

Substance	CAS No.	Application	Material/ polymer	Maximum concentration in % provided by market players
Company 1				
2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol	70321-86-7		-	-
2-(2H-benzotriazol-2-yl)-p-cresol	2440-22-4		-	-
Bumetrizole	3896-11-5		-	-
Company 2				
No information on specific substances		Foil and artificial grass	-	8% in foil 0.6% in artificial grass
Company 3				
No information on specific substances		The company is not aware whether UV absorbers are being used in the company's plastic toys		
TIETOY (European trade association for toys)				
Butyl methoxydibenzoylmethane	70356-09-1	Plastic toys for indoor use	Film	0.02%
Phenol, 2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)-phenol	70321-86-7	Plastic toys for indoor use	POM	1%
Fluorescent brightener 367	5089-22-5	Plastic toys for indoor use	PP	5%
2,4-bis(1,1-dimethylethyl)-phenol, phosphide (3:1)	31570-04-4	Plastic toys for indoor use	SEBS, PP, PA, ABS, PE, PPO, MTPO, TPE	1%
Octrizole	3147-75-9	Plastic toys for indoor use	ABS	0.5%
2,2-Dimethoxy-2-phenylacetophenone	24650-42-8		UV printing ink	10%
2-(2H-benzotriazol-2-yl)-4-methyl-phenol	2440-22-4	Plastic toys for indoor use	ABS, TPV, PA, PE, PPO	0.2% to 2%
Benzophenone-12	1843-05-6	Plastic toys for indoor use	Dyes/pigments	5.2%

Substance	CAS No.	Application	Material/ polymer	Maximum concentration in % provided by market players
Titanium dioxide (2)	13463-67-7 / 1317-70-0 / 1317-80-2		- Natural rubber CAS 9006-04-6 - PVC material - PVC printing ink	6% 0 1% 0.6%
Zinc oxide	1314-13-2	Plastic toys for indoor use	Natural rubber CAS 9006-04-6 PVC cable ABS, TPV, PA, PE, PPO	2% 0 1% 2%
Benzophenone	119-61-9	Plastic toys for indoor use	UV varnishes (solvent based)	1.38%
Butane diacid dimethylester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidine ethanol	65447-77-0	Plastic toys for outdoor use	UV stabilisation of HDPE, LLDPE, LDPE and PP	0.15-0.5%

On the basis of the list of approved UV filters and the list of UV absorbers in the CosIng database, a Danish manufacturer of toys has indicated that among these substances, four of the substances from benzotriazole group, one substance from the benzophenone family, one substance from the tert-butyl phosphite family and zinc oxide are being used in the plastics raw materials and the inks that are used. It was also reported that the substances are included at a concentration of approximately 1% in the products.

2.3.4 Paints, coatings and oils

Paints, varnishes and oils for both indoor and outdoor use, for example for boats and yachts, may contain UV-protective substances. UV filters applied in wood oils reduce the fading and greying effects of UV rays.

Paint and coatings assumed to be treated with UV filters or UV absorbers may include:

- Paints for houses, wood and metal in outdoor conditions
- Paints for walls, ceilings, woodwork and metal indoor
- Paint/varnish for cars, motorcycles, bicycles and related equipment
- Paint/varnish for boats and yachts, etc.
- Protective oils for wood used outdoors.

UV absorbers used in metallic paint for automobiles and other industrial coatings of high quality include (Köhler et al., 2010):

- Hydroxyphenylbenzotriazoles
- Hydroxybenzophenones
- Hydroxyphenyl-s-triazines
- Oxalic anilides.

Hydroxyphenylbenzotriazoles are described in the literature as the most important type of UV absorbers for automotive varnishes (Köhler et al., 2010). The substance absorbs harmful UV rays and converts them into heat. The substance has a higher photochemical resistance than oxalic anilides and hydroxybenzophenones.

For the protection of wood under paint or varnishes, titanium dioxide is used or, in the case of clear varnishes, UV absorbers or nanoscale titanium dioxide (<nm) are used (Kirk-Othmer, 2005).

UV filters, which according to information in the SPIN database are used in paints and varnishes in Denmark, are shown in Table 14.

According to the SPIN database, various benzophenone derivatives and benzotriazole are the UV filters that are registered in the largest quantities in paints and varnishes in the Danish Product Register.

TABLE 14
UV FILTERS IN PAINT AND VARNISHES REGISTERED IN THE DANISH PRODUCT REGISTER ACCORDING TO THE SPIN DATABASE (SPIN, 2014).

Substance	CAS No.	Total registered consumption in Denmark in 2011 (tonnes)	Use categories
2-(2H-benzotriazol-2-yl)-p-cresol	2440-22-4	0.1	Adhesive, paint, varnish
2-Isopropylthioxanethone (ITX)	5495-84-1	0.5	Paint and varnish, printing ink
Benzophenone-12	1843-05-6	0.6	Paint and varnish
4-MethylBenzophenone (4-MBP)	134-84-9	1	Paint and varnish
Benzophenone-3 (BP3)	131-57-7	1.1	Paint and varnish, organic solvents, floor materials (joint less floors)
2,2-Dimethoxy-2-phenylacetophenone	24650-42-8	4	Paint and varnish, printing ink
Bumetrizole	3896-11-5	4.5	Paint and varnish
Benzophenone	119-61-9	28.7	Cleaning agents, paint and varnish, polishing agents, fillers

As a part of this study, the Danish Paints and Adhesives Industry has obtained information from the association's member companies on the use of UV filters and UV absorbers. The results are shown in Table 15. It can be seen that the UV filters and UV absorbers are widely used in products for wood protection (varnishes, alkalis, oils) and in filling compounds.

TABLE 15
INFORMATION ON UV FILTERS AND UV ABSORBERS IN PAINTS, ADHESIVES, VARNISHES AND FILLING COMPOUNDS FROM THE DANISH PAINTS AND ADHESIVES INDUSTRY.

Product type	Type of UV filter/stabiliser/absorber	CAS No.	Concentration range	Protection of	
				The underlying material	The material itself
Outdoor wood varnish	Mixture of branched and linear C7-C9 alkyl 3-[3-(2H-benzotriazol-2-yl) -5-(1,1-dimethylethyl) -4-hydroxyphenyl] propionate	127519-17-9	0.5-1.0%	√	√
Wood protection	Cerium oxide nanoparticle	11129-18-3	0.10 – 0.20		√
Wood protection	Bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate	41556-26-7	0.55 – 0.70		√
Wood protection	Methyl-1,2,2,6,6-pentamethyl-4-Piperidylsebacate	82919-37-7	0.25 – 0.30		√
Primarily wood protection	Zinc oxide	1314-13-2	0.1 – 0.4	√	√

Product type	Type of UV filter/stabiliser/absorber	CAS No.	Concentration range	Protection of	
				The underlying material	The material itself
Outdoor wood oil/wood protection	Dispersion of cerium oxide	346608-13-7 (30-50%); 90622-58-5, (50-100%)	0.5.- 3		√
Wood protection	Hydroxyphenylbenzotriazol-derivate	104810-48-2	0.5 – 1.0		√
Assembly adhesive	UV-stabilisor: Mixture of: N-(2-Ethoxyphenyl)-N'-(2-ethylphenyl)oxamide, Bis(1,2,2,6,6-pentamethyl-4-piperidyl) [[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]butylmalonate and Butanedioic acid, dimethylester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol	23949-66-8, 63843-89-0, 65447-77-0	0.1-0.25		√
Furniture varnish, panel lye	Derivative of piperidine	41556-26-7, (> 70%), 82919-37-7 (20-40%)	0.20		√
Furniture varnish, panel lye	Triazole (substance group)	-	0.4-0.7	√	
Furniture varnish	Reaction products of methyl 3-(3-(2H-benzotriazole-2-yl)-5-t-butyl-4-hydroxyphenyl) propionate /PEG 300; Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy- ; Bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate; methyl 1,2,2,6,6- pentamethyl-4-piperidyl sebacate; Docusate sodium	104810-48-2, 104810-47-1, 25322-68-3 (< 90%), 41556-26-7, 82919-37-7 (< 90%), 577-11-7 (< 10%)	1%		√
Clearcoat shiny	Benzotriazol hydroxyphenyl derivatives	Not known	0.4-0.5	√	
UV Filters in all clearcoats and two-component binders.	UV absorbers of the benzotriazole class and Hindered Amine Light Stabilizer from the piperdinyl class. The name is confidential.	Confidential	Supplier, know-how and confidential		√
Sealants	Bis(1,2,2,6,6-pentmethyl-4- piperidyl)sebacate	41556-26-7	0.11		√
Sealants	Methyl-1,2,2,6,6-pentethyl-4-piperidylsebacate	82919-37-7	0.04		√

Product type	Type of UV filter/stabiliser/absorber	CAS No.	Concentration range	Protection of	
				The underlying material	The material itself
Sealants	UV stabilizer: Mixture of: N-(2-Ethoxyphenyl)-N'-(2-ethylphenyl)oxamide, Bis(1,2,2,6,6- pentamethyl-4- piperidyl) [[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]butylmalonate, Butanedioic acid, dimethylester, polymer with 4-hydroxy-2,2,6,6- tetramethyl-1-piperidineethanol	23949-66-8, 63843-89-0, 65447-77-0	0.1-0.25		√
Sealants	Hydroxyphenyltriazine	153519-44-9	0.15%		√
Clearcoats for boats, solvent-based	Bumetrizole	3896-11-5	0.3-0.5%	√	
Clearcoats for boats, water-based	alpha-3-[3-(2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1- omega-hydroxy-poly(oxyethylene) and alpha-3-[3-(2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1- omega-3-(3-(2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl)propionyloxypoly(oxyethyl)	Not known	0.5-1%	√	
Dissolved and held in a cross-linked matrix	Reaction mass of bis (1,2,2,6,6-pentamethyl-4-piperidyl sebacate and methyl 1,2,2,6,6-pentamethyl-4-piperidyl sebacat)	41556-26-7, 82919-37-7	0.3-0.5%		√
Silicone alkyd	Bumetrizole	3896-11-5	0.2-0.3%		√
Polysiloxanes	Reaction mass of bis (1,2,2,6,6-pentamethyl-4-piperidyl sebacate and methyl 1,2,2,6,6-pentamethyl-4-piperidyl sebacat)	41556-26-7, 82919-37-7	0.3-0.5%		√
Clearcoats and solvent borne solid colour top coat	Benzotriazole type	Not specified	0.2% - 1.1%	√	√
Clearcoats and solvent borne solid colour top coat	Pentamethyl piperidyl sebacate type	Not specified	0.1% - 1.8%	√	√
Clearcoats and solvent borne solid colour top coat	3-glycidyloxypropyltrimethoxy silane type	Not specified	0.5% - 0.9%	√	√
Clearcoats and solvent borne solid colour top coat	Hydroxyphenyltriazine	153519-44-9	0.4% - 1.0%	√	√

2.3.5 Food packaging

UV-absorbers and UV filters are added to food packaging to protect the packaging and the contained food from harmful UV light. It is, as discussed further below, demonstrated that these substances are able to migrate into food and beverage products. Substances detected in food and beverages are listed in the tables below.

Packaging that are expected to be treated with UV filters or UV absorbers may include:

- Plastic bottles for drinks (beer, soft drinks, juices, mineral water, etc.)
- Plastic film and trays etc. for the packaging of meat, fish, vegetables, nuts, etc.

In addition, UV-sta bilizing substances are used in UV-curing inks and varnishes for paper and cardboard packaging for sugar, flour etc. The substances, e.g. benzophenone, can also be found to a certain extent in packaging made of recycled paper or cardboard if the manufacturing process did not adequately remove the substances from the material (EFSA, 2009). The use of UV-stabilizing substances in inks for food packaging is described in section 2.3.6.

According to the Regulation on plastic materials and articles intended to come into contact with food (No. 10/2011 of 14 January 2011), only substances listed in the EU list of approved substances of Annex I (hereinafter referred to as the »EU list«) of the Regulation may intentionally be used in the manufacture of plastic layers in plastic materials and articles. This applies to all additives other than dyestuffs and thus also to UV filters. Additives not listed in the EU list, however, may continuously be used in accordance with national law after 1 January 2010, until a decision on their inclusion in the EU list is issued, provided they are listed on a preliminary list.

Examples of UV filters and UV absorbers used in polymer materials, and which have been measured in food (FPF, 2013a), are shown in Table 16.

TABLE 16
UV FILTERS AND UV ABSORBS USED IN POLYMERS AND MEASURED IN FOODS (FPF, 2013A).

Substance	CAS No.	Use in packaging
Benzophenone-3	131-57-7	UV absorber in plastic
Benzophenone-1	131-56-6	UV absorber and stabilizer for lacquer coatings, polyolefins, polyvinyl chloride, etc.
4-aminobenzoic acid	150-13-0	UV absorber
2-(2H-benzotriazol-2-yl)-4-methyl-phenol	2440-22-4	UV absorber, used in PET bottles
2-(2'-Hydroxy-3',5'-di-tert-butylphenyl)-5-chlorobenzotriazole	3864-99-1	UV absorber, used in PET bottles
Bumetrizole	3896-11-5	UV absorber, used in PET bottles
2-benzotriazol-2-yl-4-(2,4,4-trimethylpentan-2-yl)phenol	52188-76-8	UV absorber, used in PET bottles
Phenol, 2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)-phenol	70321-86-72	UV absorber, used in PET bottles
2-(4,6-Diphenyl-1,3,5-triazine-2-yl)-5-[(hexyl)oxy]-phenol	147315-50-2	UV absorber, used in PET bottles
4,4'-DihydroxyBenzophenone	611-99-4	UV-filter, used in PC plastics and printed circuit boards

Some of the contacted manufacturers and distributors of beverages and foodstuffs indicated that they do not use UV filters or UV absorbers in PET bottles. Others stated that they had no information available. Therefore, it is not possible to conclude whether the substances are present in PET bottles on the Danish market.

2.3.6 Printing inks for industrial use and food packaging

In order to obtain information on the use of UV filters and UV absorbers in printing inks, a manufacturer was contacted, who stated that UV-protective substances are only used for two applications:

- For industrial products to be used outside - for example, road signs - UV absorbers of the benzotriazole type are typically used.

- For UV-curing inks and varnishes, where the substances act as photo initiators (UV-curing agents), a number of substances are used, including:

  - 4-(4-Methylphenylthio)benzophenone; (CAS No. 83846-85-9)
  - 2,2-Dimethoxy-2-phenylacetophenone; (CAS No. 24650-42-8)
  - 4-Benzoylbiphenyl; (CAS No. 2128-93-0)
  - Benzophenone; (CAS No. 119-61-9)
  - Ethyl 4-dimethylaminobenzoate; (CAS No. 10287-53-3)
  - Ethoxylated ethyl-4-aminobenzoate; (CAS No. 116242-27-4)
  - 2-Ethylhexyl 4-(dimethyzoatelamino)benzoate; (CAS No. 21245-02-3).

Examples of UV filters and UV absorbers used in UV-curing printing inks and varnishes for paper and board food packaging and which have been measured in foodstuff (FPF, 2012) are shown in Table 17.

TABLE 17
UV FILTERS AND UV ABSORBERS IN UV-CURING INKS AND VARNISHES USED FOR PAPER AND BOARD FOOD PACKAING AND WHICH HAVE BEEN MEASURED IN FOODSTUFF (FPF, 2012)

Substance	CAS No.	Use
4-methyl-benzophenone	134-84-9	Photo initiator, printing ink for paper and board packaging.
Benzophenone	119-61-9	Photosensitizing. Used in printing ink for paper and board packaging.
4-benzobiphenyl	2128-93-0	Photo initiator. Used printing ink for paper and board packaging.
Ethyl 4-dimethylaminobenzoate	10287-53-3	UV absorber. Used in printing ink for paper and board packaging.
2-ethylhexyl-4-dimethylaminobenzoate	21245-02-3	UV absorber. Used in printing ink for paper and board packaging.
2,2-Dimethoxy-2-phenylacetophenon	24650-42-8	UV absorber. Used in printing ink for paper and board packaging. Found in beverages and milk products from various supermarkets in Spain.
4-(4-Methylphenylthio)benzophenone	83846-85-9	Photo initiator. Used printing ink for paper and board packaging.

In 2009 the German authorities reported the migration of 4-methylbenzophenone from packaging to certain cereal products at a level of 798 µg/kg to RASFF (The Rapid Alert System for Food and Feed) in accordance with the early warning system described in Article 50 of the Food Regulation[15]. According to the German authorities, the contamination of the products originated from the migration of 4-methylbenzophenone from the printed surface of the cardboard packaging in which

[15] Regulation (EC) no 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety.

the substance is used as photo-initiator in UV-cured varnish. The Belgian authorities subsequently reported levels of up to 3729 µg/kg developed during storage. As a result of these reports, in 2009 the EU Standing Committee on Food issued a recommendation to Member States that food contact materials with printed surfaces containing 4-methylbenzophenone or benzophenone may not come into contact with food, unless it has been demonstrated in the company's internal documentation that the total amount of 4-methylbenzophenone or benzophenone released to the food is below 0.6 mg/kg food.

The European Printing Ink Association (EuPIA) and the European Association of Cartonboard Manufacturers) subsequently recommended that their members not use printing inks containing the two substances for printing of food packaging, unless there is a functional barrier that blocks the release of the substances to food, including the gas phase (European Commission, 2009). The barrier may be composed of aluminium, PET/SiOx or similar materials.

The Danish Veterinary and Food Administration reported in 2010 on a project where packaging for use in contact with dry food was analysed (Fødevarestyrelsen, 2010). The packages were chosen based on knowledge or suspicion that print with UV-curing printing inks had been used. A total of 37 samples of unused packaging of cardboard or paper were analysed by screening (extraction). The screening study revealed the presence of 4-benzoylbiphenyl (PBZ), which gave cause for an investigation of the migration to food for four products. For those samples where it was claimed that a functional barrier was being used, this same functional barrier was also used in the migration test.

There are no specific migration limits for 4-hydroxybenzophenone, 4-benzoylbiphenyl and 2-isopropylthioxanethon (ITX). Indicative action limits were therefore used in the report in order to evaluate the results. 4-hydroxybenzophenone (HBB) is included in the sum of benzophenone (BP) and 4-methylbenzophenone (4MBP) since a common TDI (tolerable daily intake) for 4-hydroxybenzophenone (HBB) and benzophenone-2 has been established. The limit values for ITX and 4-benzoylbiphenyl are taken from the "Suitability List" (EuPIA, 2013).

The substances from the investigation included:

- Benzophenone, CAS No. 119-61-9 (BP)
- 4-Methylbenzophenone, CAS No.134-84-9 (4-MBP)
- 4-Benzoylbiphenyl, CAS No. 2128-93-0 (PBZ)
- 2-Isopropylthioxanethon, CAS No. 5495-84-1 (ITX)
- 4-Hydroxybenzophenone, CAS No. 1137-42-4 (HBB)

BP was found in most samples, while 4-MBP was not found in any of the samples. BP was detected at the highest level of 20 µg/dm² in packaging for fast food. PBZ content above the action limit was found in four samples when screening 37 samples of paperboard material. Migration tests performed on these samples did not show findings of photo-initiators above the action limits.

In a German study from 2013, 310 food contact materials containing dry food were analysed for the content of 11 photo-initiators and amine synergists[16] previously found in food, including BP and ITX. BP was found in 49% of the packaging samples, whereas the other photo initiators were found in less than 10% of samples. The highest content of BP was found in the cardboard packaging for cacao at levels of 2,510 µg/dm². Packaging for muesli, Indian pappadums and cereal products (grains) also contained high levels of photo initiators (FPF, 2013b).

In the same study, the researchers examined the content of photo-initiators and amine synergists in foodstuff contained in packaging without distinct barrier material such as aluminium foil, and

[16] Amine synergists are added to some UV filters such as benzophenone in UV-curing inks in order to promote the curing process.

found the presence of photo initiators or amine synergists in 33 out of 99 foodstuffs. Twenty foodstuffs contained photo-initiators or amine synergists above the regulatory limits set out in Article 3 of Regulation (EC) 1935/2004 and Article 14 of Regulation (EC) 178/2002. In 12 of the 23 food samples where BP was identified, the regulatory limit of 0.6 mg/kg was exceeded. In total, eleven products exceeded the migration limits specified in the Swiss legislation as follows: for methylbenzophenone (MBP) (6), methyl-o-benzoylbenzoate (Mobb) (3), ethyl 4-dimethylaminobenzoate (EDAB) (1) and 2-ethylhexyl 4- (dimethylamino)-benzoate (OD-PABA) (1), respectively. The researchers confirmed that the polyethylene barrier was permeable to BP and that BP also migrates via the gas phase regardless of the presence of paper or polypropylene barriers (FPF, 2013b).

There is no specific regulation of printing inks for food contact materials in the EU beyond the general principles of EU Regulation 1935/2004 on materials and articles intended for contact with food. The regulation requires that substances must not be released to foodstuffs in quantities which may pose a hazard to human health. In Switzerland there are rules for printing inks, which also include a positive list and specific migration limits that are frequently updated.

In Regulation (EC) No. 10/2011 on plastic materials and articles intended for contact with food, an overall migration limit of 6 mg/kg food is set for a number of benzophenones as well as a limit value for benzophenone of 0.6 mg/kg food from food contact materials of plastic.

2.3.7 Cleaning agents and detergents

Two of the largest manufacturers of cleaning agents and detergents in Denmark have been contacted regarding the use of UV filters and UV absorbers in cleaning agents and detergents. One of the companies reported the use of UV filters in detergents up until 2010. Today, none of the two companies make use of the substances in their products. There was no information available on whether there could be other manufacturers that could be using UV filters and UV absorbers in detergents or cleaning products or which substances were likely to be used.

Searching the Internet provided only limited results using search terms such as UV filter, UV absorber, detergents, detergents, etc. in Danish, English and German. Among the findings was a German patent for a liquid detergent containing capsules with active substances, including a UV absorber (DE 2007). Identified references on the Internet to specific detergents with UV protection for textile washing were no longer active.

Registrations for a number of substances list the product category PC 35 "Washing and cleaning products." This is cf. Annex 2 and 3 the case for benzophenone (CAS No. 119-61-9), benzyl salicylate (CAS No. 118-58-1), disodium distyrylbiphenyl disulfonate (CAS No. 27344-41-8), fluorescent brightener 230 (CAS No. 27344-06-5), sodium benzotriazolyl butylphenol sulfonate (CAS No. 92484-48-5) and t-butyl benzoyl peroxide (CAS No. 614-45-9). The fact that it mentions “possible” applications, however, does not mean that the substances are necessarily being used for this application.

On the present basis, it cannot be ruled out that UV filters are being used in cleaning products and detergents on the Danish market, but no specific information to confirm such use has been found.

2.3.8 Other uses

Other possible fields of applications for UV filters and UV absorbers, according to a search on the Internet, include:

- Glue;
- Optical fibres;
- Pulp and paper (articles planned to last for decades and centuries);
- Roofing materials (other than plastic);

- Photographic equipment (improved imaging);
- UV protection films and coatings (e.g. protection of artwork and furniture);
- Leather cleaning and care products (e.g. protection of underlying leather);
- Contact lenses and sun glasses (to protect the eyes).

2.4 REACH registration status of UV filters and UV absorbers

The REACH registration status of UV filters approved for use in cosmetics is shown in Appendix 1 of this report.

The results of a search in the ECHA databases and the EU ESIS (European Chemical Substances Information System) database, before it was shut down in October 2013, for the identified UV filters and UV absorbers are summarized in Appendix 2. The substances are grouped by type in the table. The main type or group of UV absorbers identified in the study are as follows:

- Benzophenone derivatives
- Benzotriazole derivatives
- Benzylidene malonate derivatives
- Triazine derivatives
- Other, including carbon black.

It should be emphasised that the procedure (described in section 2.1.1) does not necessarily identify all relevant UV absorbers used in the EU, but it is most likely that the most common types or groups of UV absorbers have been identified. Several of the substances were also not listed in the EU ESIS database. This could indicate that the substances are "new chemicals" and are registered as such under REACH.

Although the information has been obtained from publicly available sources, some of the visited websites emphasise that certain information should not be made available for a third party. Furthermore, a clear correlation between the identity of an active substance and a given commercial product is not always presented in the publicly available material. However, it has been possible to obtain a correlation for many of the products listed in the appendix.

Furthermore, the list of approved UV filters and UV absorbers listed in the CoSing database (October 2013) have been crosschecked against the ECHA database of REACH registrations. The results are shown in Appendix 1 and Appendix 3.

The following is included in the registration information for the 2713 approved UV filters:

- 4 substances are neither pre-registered nor registered
- 7 substances have a pre-registration status
- 3 substances are registered in the tonnage range: 10 – 100 t/year
- 8 substances are registered in the tonnage range: 100 – 1,000 t/year
- 3 substances are registered in the tonnage range: 1000 – 10,000 t/year
- 1 substance is registered in the tonnage range: 1,000,000 – 10,000,000 t/year.

The registered tonnage of the individual UV filters is shown in Appendix 1 along with information from the SPIN database on applications reported to the Danish Product Register in 2011. Cosmetic products are excluded from the notification requirements of the Danish Product Register, which only contains information on dangerous chemical substances and materials used commercially in quantities exceeding 100 kg per year. The reported use volumes of UV filters and absorbers therefore originate from uses other than in cosmetic products. UV filters (defined as hazardous) used in the manufacture of cosmetic products or other product types, which may lead to consumer exposure (such as paint) are, however, covered by the registration.

Titanium dioxide, which has many uses, is not unexpectedly the substance which is registered in the highest tonnage level under REACH. Among the three substances registered in the tonnage band of 1,000 – 10,000 t/year, butyl methoxydibenzoylmethane (CAS No. 70356-09-1) is primarily used in relation to cosmetics, perfume and fragrances, while octocrylene (CAS No. 6197-30-4) and ethylhexyl methoxycinnamate (CAS No. 5466-77-3) also have other applications and are used in articles of paper and plastic according to the registrations, to which consumers may safely be exposed.

2.5 Monitoring

2.5.1 UV filters and UV absorbers found in drinking water, the aquatic environment and biota

Drinking water

Several studies have shown the presence of UV filters in the environment and in drinking water extracted from surface water in Europe and USA. In that context it should be mentioned that the Danish drinking water supply is based almost entirely on groundwater. Sources of the occurrence of UV filters in the aquatic environment have been identified as direct input as a result of recreational activities (e.g. the release of UV filters from sunscreen on the skin during swimming) and indirect input mainly via sewage treatment plants (e.g. . as a result of the use of cosmetics, including sun screen, showering or washing of textiles) as well as from industrial waste water (Díaz-Cruz et al., 2012; Poiger et al., 2004).

Días-Cruz et al. (2012) investigated the occurrence of five UV filters in different clean water samples (bottled mineral waters, tap water, well-water and tap water treated with ion-exchange resins) from Barcelona. The tap water and the ion-exchanged tap water originated from the rivers Llobregat and Ter, which supplies the area with drinking water. The two rivers are connected, but are different with regard to the environmental load. Llobregat is subject to both urban and industrial pressure as well as mining activities, while Ter is primarily affected by agricultural practices. The five UV filters were: benzophenone-3 (BP-3; CAS No. 131-57-7), octocrylene (OC; CAS No. 6197-30-4), ethylhexyl methoxycinnamate (OMC; CAS No. 5466-77-3), 4-methylbenzylidene camphor (4-MBC; CAS No. 36861-47-9) and 2-ethylhexyl 4-(dimethylamino) benzoate (OD-PABA; CAS No. 21245-02-3). The results showed that none of the UV filters were detected in bottled mineral waters and ionic-exchange resins treated water (or the concentration was below the limit of quantification (LOQ)). The tap water did not contain either 4-MBC or OD-PABA, but rather a mean concentration of 870 ng/L OMC and 290 ng/L OC was found. The only UV-filter found in the well water was OMC in a mean concentration of 770 ng/L. The findings of OMC and OC in tap water encouraged a more comprehensive study of the occurrence of UV filters in tap water samples taken every second day for 14 days from three different locations in Barcelona city. Results showed that BP3, 4-MBC, OD-PABA, OMC and OC were present in samples from all three locations in the first 3 days, and OMC and OC were present in all samples at all time-points. The concentrations were in the range of 22-295 ng/L (3BP), 10-35 ng/L (4-MBC), 1.9-115 ng/L (OD-PABA), 1.5-256 ng/L (OMC) and 33-167 ng/L (OC). The concentrations of all five UV filters in tap water were greatest from a specific location ("Tap 1"), where the highest proportion of water was supplied from Llobregat River. This river is, as mentioned, highly affected by both urban and industrial activities. The results indicate that the primary source of UV filters in the drinking water in this case is from indirect inputs from waste water as well as industrial waste. The ion-exchange treatment appeared effective in decreasing the concentration of the measured UV filters, especially the polar BP3, where the concentration was reduced by half.

Stackelberg et al. (2004) investigated the extent to which 106 organic waste water contaminants, including benzophenone, could survive conventional water treatment (in USA) and occur in finished-water supplies intended for human consumption. Samples were taken from raw water,

which originated from two input streams heavily affected by waste water discharge. The highest concentration of benzophenone found in the samples of finished drinking water was 0.13 µg/L. These results indicate that the conventional water treatment process was insufficient in removing the compound from the drinking water.

Poiger et al. (2004) investigated the occurrence of UV filter compounds from sunscreens in surface water. Two Swiss lakes, Lake Zurich and Lake Hüttnersee, were selected as study areas, as both lakes are used for recreational activities and therefore reasonable direct inputs of UV filters from sunscreen would be expected. Lake Zurich is furthermore an important drinking water resource. Possible additional indirect input from waste water treatment plants (WWTPs) were not considered in this study, even though Lake Zurich has many WWTPs discharging to the lake. Lake Hüttnersee has no WWTPs discharging to the lake. Five UV filter compounds were selected as target compounds for surface water analysis: OMC, MBC, OC, butyl methoxydibenzoylmethane (BMDBM; CAS No. 70356-09-1) and BP3. The concentrations in Lake Zurich were in the range of <2–22 ng/L (MBC), <2–26 ng/L (OMC), and <2–4 ng/L (BP3). Concentrations of OC and BMDBM in this lake were below the detection limits of 2 and 20 ng/L, respectively. Concentrations of UV filters in Hüttnersee were in the range of 5–125 ng/L (BP3), <2–82 ng/L (MBC), <2–27 ng/L (OC) and <2–19 ng/L (OMC). BMDBM was detected only in one sample above the detection limit (24 ng/L). The concentrations of UV-filters in the surface water showed great seasonal variations, with highest concentrations in the summertime, as expected due to extensive recreational activity. The results indicate that different removal processes, such as biodegradation, are affecting the concentration of the UV filters. By correlating the actual concentrations of UV filters in the lakes with the population discharges via WWTPs to the lakes, the data indicate that the indirect input via waste water may be less important than the direct input, at least during the summertime where the lakes are extensively used for swimming etc.

Loraine and Pettigrove (2006) report findings of *inter alia* benzophenone (not further identified) in raw and treated drinking water from four different water filtration plants, receiving water from the Colorado River and the California State Water Project. The investigation demonstrated the occurrence of several polar organic medical substances and personal care products, including sun screen. The concentration of benzophenone in the non-treated drinking water was in the range of 0.36-0.79 µg/L, while the mean concentration in the treated drinking water was 0.26 µg/L. Similar to Stackelberg et al. (2004), these results indicate that the compound is only partly removed in the water treatment process and is therefore found in the treated drinking water. Seasonal variations in the occurrence of benzophenone were also investigated, and the results showed higher concentrations in the dry season (August to November), which indicates a connection to the increased use of sunscreens in the summer. Lower water supply is also a contributing factor to the higher concentration. It is not clear how much each of the two factors contribute to the differences.

Aquatic environment and biota

The presence of UV filters in the aquatic environment has been reported since the early 1980s, mainly in freshwater. French studies have shown that organic UV filters (OMC, OC and OD-PABA) accumulate in marine mussels from French coastal areas. The measured concentrations increased with the increasing air temperatures and recreational use in the summer, and in mussels collected in closed sampling sites (Bachelot et al., 2012).

Grabicova et al. (2013) investigated the environmental concentrations in the Czech Republic of different UV filters, including BP-3, in different surface waters from popular summer bathing locations, recreational lakes and rivers downstream of contamination sources (e.g. holiday camps and WWTPs). The concentration of BP-3 was found in the range of 21-620 ng/L, with the highest concentrations measured at bathing locations and recreational lakes / ponds, where the concentrations were approximately 10 times higher than in the rivers downstream of the WWTPs.

Swiss studies have shown that some lipophilic UV filters accumulate in biota and act as endocrine disrupters. One of these studies has shown concentration of 4-MBC and OC,in the muscular tissue in fish (brown trout, *Salmo truttafario*) from seven smaller Swiss rivers which received input from WWTPs (Buser et al., 2006).

The Norwegian Environmental Protection Agency has conducted a screening study of *inter alia* different organic UV chemicals in order to determine whether these substances are released to the environment and if so, whether the released levels are problematic, or whether the existing use may lead to environmental problems in the future (Miljødirektoratet, 2014). The investigation also included organic peroxides, new bisphenols, selected PBTs as well as several phosphorus-based flame-retardants and the insecticide DEET (N, N-Diethyl-m-toluamide). The investigation confirmed that UV filters and UV absorbers are released into the environment through effluents from sewage treatment plants and sewage sludge.

The report summarises the results for the UV substances as follows: "The organic UV-filters benzophenone-3 (BP3), ethylhexylmethoxycinnamate (EHMC), octocrylene (OC), and 2-(2H-benzotriazol-2-yl)-4,6-bis(2-phenyl-2-propanyl)phenol (UV-234) were detected in treated wastewater and leachate. Concentrations of OC were an order of magnitude higher in the samples from Tomasjord than VEAS or HIAS WWTWs. BP3, EHMC, OC, 2-(5-chloro-2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-propanyl)phenol (UV- 327) and 2-(2H-benzotriazol-2-yl)-4-(2,4,4-trimethyl-2-pentanyl)phenol (UV-329) were the organic UV filters detected in sludge. Organic UV chemicals also occur in sediments collected from the respective recipients, with EHMC, OC, UV-327, 2-(2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-butanyl)phenol (UV-328) present in the sediments collected from Oslofjord, with only EHMC present in Mjøsa sediments. A number of the UV filters (BP3, ODPABA, EHMC, UV-238[17] and OC) were also detected in Oslofjord cod livers, although there was no evidence of biomagnification through the organisms collected"[18] (Miljødirektoratet, 2014). An evaluation of the environmental risk linked to release of the organic UV filters detected in sludge is difficult as data regarding their ecotoxicity are missing.

The report concludes that BP-3, OMC (abbreviated EHMC in the Norewgian report), OC, UV-234, UV 327 and UV-329 are released into the environment via waste water and sludge; that leachate from landfills is a source of UV-234, OC, BP-3 and OMC in the environment; that OMC, OC, UV-327, UV-328 can accumulate in marine and freshwater sediments that receive treated wastewater; that BP-3 OD-PABA, OMC, OC, UV 328 and UV-327 accumulates in biota in the Oslo Fjord; that BP-3, and OC OMC accumulates in Mjøsa; and BP-3 and that OC may pose a risk among others to surface waters, which is a source of drinking water (Miljødirektoratet, 2014).

In a review by Gago-Ferrero et al. (2012), levels of organic UV filters in biota, as well as the ecotoxological effects of the compounds in the aquatic environment were investigated. Out of all the studied UV filters, which included benzophenones, aminobenzoic acid derivatives, salicylate, cinnamates, camphor derivatives, dibenzo methane derivatives and crylenes, OMC was the most frequently found UV filter in aquatic biota. Concentrations of OMC were however lower than those reported for UV filters of similar log Kow, such as homosalate (HMS; CAS No. 118-56-9) and OC (Gago-Ferrero et al., 2012).

Several studies have confirmed the occurrence of UV filters in fish. The presence of different UV filters in perch (*Perca fluviatilis*) and roach (*Rutilus rutilus*) from a German lake were analysed and reported for the whole fish. The reported concentrations were in the range of 20 – 237 ng/g lipid

[17] The report cites UV-238 in this context, but it is assumed to be an error, as this this trade name does not seem to exist and the name is only found in connection with the CAS No. for UV 328.
[18] Text is taken from the English summary of the report from Miljødirektoratet (2014), which is not identical with the Norwegian text reported in the Danish version of this report.

and 120-930 ng/g lipid in roach and perch, respectively. HMS and 4-MBC were found in the highest concentrations in the two species (Nagtegaal et al. 1997).

A more recent study investigated the concentrations of four different UV filters (4-MBC, BP-3, OMC and octocrylene) in white fish (*Coregonus* sp.), roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*) from a Swiss lake. None of the UV filters were quantified in white fish. Concentrations were in the range of 44-118 ng/g lipid in roach, with BP-3 found in the highest concentrations. For perch, the range was 25-166 ng/g lipid, with 4-MBC found in the highest concentrations (Balmer et al., 2005). The concentration of OMC in two other fish species, barb (*Barbus barbus*) and chub (*Leucisus cephalus*) were in the range of 45-700 ng/g lipid (Zenker et al., 2008). Samples of fish (*S. Trutta fario*) from a river downstream of a WWTP discharge contained higher levels of 4-MBC and octocrylene, 1800 and 2400 ng/g lipid respectively. The levels of organic UV filters measured in biota are comparable to the levels of polychlorinated biphenyls (PCBs), persistent organic pollutants banned a few decades ago (Diaz-Cruz et al., 2008).

The presence of UV-filters has also been confirmed in organisms other than fish. In a French study, the presence of UV residues in marine mussels was investigated. The results showed that all samples contained OMC, at concentrations of up to 256 ng/g lipid, and 55% of the samples also contained octocrylene (Bachelot et al., 2012).

In a Swiss study, levels of OMC in crustaceans (*Dammarus sp.*) and molluscs (*Dreissena polymorpha*) were in the range of 99-133 and 22-150 ng/g lipid, respectively. OMC was also found in different fish species, in concentrations of up to 337 ng/g lipid and concentrations in cormorant (*Phalacrocorax sp.*) were in the range of 16-701 ng/g lipid. These results may indicate that biomagnification occurs through the food chain; however, the higher concentration in cormorant compared to fish was not statistically significant (Fent et al., 2010).

Gago-Ferrero et al. (2013) were the first to investigate the presence of UV filters, in this case OC, in mammal liver tissue from the Franciscana dolphin (*Pontoporia blainvillei*). OC was present in 21 out of 56 samples, in the concentration range of 89-782 ng/g lipid weight.

Because of the lipophilic character of many UV filters, bioaccumulation of the substances may be expected. However, according to Gaga-Ferrero et al. (2012), the above-mentioned study by Fent et al. (2010) is the only field study where biomagnification through the food chain has been investigated. Bioconcentration of 4-MBC in roach was investigated by Balmer et al. (2005), which calculated a lipid-based bioconcentration factor (BCF) of 9300-23.000 (logBCF = 4.0-4.4).

Most ecotoxicological studies on the effect of UV filters have been conducted *in vivo* on different species of fish. Several UV filters have been found to have estrogenic hormonal activity, specially 4-MBC and OMC. Coronado et al. (2008) investigated the estrogenic activity of BP-3 in rainbow trout and Japanese medaka. Fourteen days' exposure of juvenile rainbow trout to BP-3 resulted in significant expression of plasma vitellogenin at a median concentration of 749 µg/L. Vitellogenin induction was also observed for Japanese medaka at a concentration of 620 µg/L. Both concentrations are very high compared to the concentration of BP-3 found in natural waters and wastewater effluents.

2.5.2 UV filters and UV absorbers identified by human biomonitoring

The many applications areas of UV filters and UV absorbers provide the possibly for exposure of consumers through the consumption of food and beverages, release and migration from articles, dust containing the substances and through direct skin contact with mixtures, such as cosmetics and personal care products as well as via drinking water. Exposure via inhalation is also possible, depending on the extent to which the substances can evaporate into the air from products used or

stored indoors. It is believed that several of the organic compounds used as UV filters or UV absorbers, e.g. in polymers, may migrate and thus have the potential for evaporation.

Examples of UV absorbers identified in various biomonitoring studies (plasma, urine, breast milk) in the US and Europe are shown in Table 18. It should be emphasized that the samples have only been analysed for selected UV absorbers and it is therefore possible that other UV protecting substances may be present in human body fluids.

TABLE 18

OVERVIEW OF EXAMPLES OF BIOMONITORING OF UV FILTERS IN BLOOD, URINE AND BREAST MILK.

Substance	CAS No.	Country	Subjects	Media	Mean concentration	Reference[3]
BP-3	131-57-7	DK (2010-12) (2004)	Children Mothers Men Women[1]	Urine Urine Urine Urine	1.8 ng/mL 3.7 ng/mL 140 ng/mL 60 ng/mL	Democophes, 2013 Krause et al., 2012
		USA (2003-04) (2005-06) (2007-08) (2009-10)	> 6 years Pregnant > 6 years > 6 years > 6 years	Urine Urine Urine Urine Urine	22.9 ng/mL 7.5 ng/mL 19.4 ng/mL 18.3 ng/mL 22.3 ng/mL	Krause et al., 2012 Krause et al., 2012 CDC, 2014 CDC, 2014 CDC, 2014
		FR (2003-2006)	Pregnant women	Urine	1.3 ng/mL	Krause et al., 2012
		CH (2004-2006)	Women	Breast milk	26.7 ng/g lipid	Schlumpf et al., 2010
		BE (2013)	Children Men Women	Urine Urine Urine	1.6 ng/mL 0.9 ng/mL 1.7 ng/mL	Dewalque et al., 2014
4-MBC	36861-47-9	DK (2004)	Men Women[1]	Urine Urine	7 ng/mL[2] 5 ng/mL[2]	Krause et al., 2012
		DK (2008)	Men Women[1]	Urine Urine	4 ng/mL[2] 4 ng/mL[2]	Krause et al., 2012
		CH (2004-2006)	Women	Breast milk	18.7 ng/g lipid	Schlumpf et al., 2010
OMC	5466-77-3	DK (2004)	Men Women[1]	Urine Urine	8 ng/mL[2] 5 ng/mL[2]	Krause et al., 2012
		DK (2008)	Men Women[1]	Urine Urine	4 ng/mL[2] 6 ng/mL[2]	Krause et al., 2012
3-BC[19]	15087-24-8	CH (2004-2006)	Women	Breast milk	0 ng/g lipid	Schlumpf et al., 2010
HMS	118-56-9	CH (2004-2006)	Women	Breast milk	15.50 ng/g lipid	Schlumpf et al., 2010
OC	6197-30-4	CH (2004-2006)	Women	Breast milk	28.32 ng/g lipid	Schlumpf et al., 2010
OD-PABA	21245-02-3	CH (2004)	Women	Breast milk	49.0 ng/g lipid	Schlumpf et al., 2010

1: Women in menopause
2: Maximum median concentration. It is not evident from the reference what the precise meaning of this is.
3: The sources are generally secondary sources (review articles); for additional information on primary sources, reference is made to these sources.

[19] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

These substances are all approved UV filters for cosmetics. It is probably less likely that UV filters/absorbers, which are primarily included in other types of products, have been included in biomonitoring studies to a greater extent.

Measurements of BP-3 levels in Danish women's urine in 2004 compared with 2010-12 could indicate a decrease in exposure. It is not clear, however, whether the measurements were made at the same time of the year.

Schlumpf et al. (2010) compared the results of questionnaires sent to selected cohorts from 2004, 2005 and 2006, respectively, with levels of 8 UV filters (OMC, OC, 4-MBC, HMS, BP-3, BP-2, OD PABA and 3-BC) measured in breast milk and found a positive correlation between the use of cosmetics containing UV filters and levels in breast milk for 4-MBC and OC. Use of cosmetics containing each of the 8 investigated UV filters were also positively correlated with the presence of the substance in breast milk. For OMC correlation was not statistically significant, and this was assumed by the authors to be due to the fact that not all applications were covered in the questionnaire. The data material was too limited for correlation statistics for the other substances. BP-2 was not found, despite that the use of the substance was reported, and the reason for this has not been determined. 3-BC was also not found in either products or milk samples. In contrast to the positive correlation with the use of cosmetics, no correlation between the UV filters in milk and maternal age, body weight, body mass index, address (city, suburb, rural) or nutritional parameters (intake of fish, red meat, frequency, amount of consumption and fat content in milk and cheese) was found. An inverse correlation of the most common UV-filters and PCB congeners was observed, indicating differences in the exposure pattern compared to the POP contaminants. UV filters are widespread in aquatic ecosystems and have been shown to bioaccumulate in invertebrates and fish, but their presence in human tissue seems more likely to be correlated with the consumer habits than with environmental exposure (Schlumpf et al., 2010). It should be emphasised that the questionnaire did not pick up on other uses of UV filters or UV absorbers in various other articles, such as textiles.

A comparison of samples collected in August/September and in November/December did not show marked seasonal differences, even in the case of two UV filters used exclusively (4- MBC) or almost exclusively (OCT) in sunscreens (Schlumpf et al., 2010).

Application areas for substances found by biomonitoring

To provide an overview of the uses of the substances identified by biomonitoring in humans, results from the survey and information about registered applications from REACH registrations and the SPIN database are summarised in Table 19.

TABLE 19
OVERVIEW OF APPLICATIONS OF SUBSTANCES FOUND BY BIOMONITORING IN HUMANS

Substance	CAS No.	Application areas identified in the survey	Registered applications under REACH and in the SPIN database [1]
BP-3	131-57-7	Cosmetics, in the present survey found in face cream; eau de toilette; foundation; hand cream; lip balm; sun screen; eye cream. Found in 17 products out of 291, including 4 sunscreens. Is not mentioned as being used by the cosmetics industry. UV absorber in plastic, stabilizer in plastics for food packaging, paints and varnishes	REACH: cosmetics and personal care products, coatings and paints, thinners, paint removes, fillers, putties, plasters, modelling clay, finger paints. SPIN: Paints and varnishes, flooring materials
4-MBC	36861-47-9	Cosmetics – found by Rastogi (2002), but not in the present survey, and not mentioned as being used by the cosmetics	REACH: Pre-registered SPIN: No notifications

Substance	CAS No.	Application areas identified in the survey	Registered applications under REACH and in the SPIN database [1]
		industry.	
OMC	5466-77-3	Cosmetics, in present survey found in face cream; conditioner; body wash; eau de toilette; foundation; hand cream; hair treatment; hair oil; lip balm; makeup; perfume; primer/cream; shampoo/conditioner; sun screen; eye cream. Found in 59 products out of 291, including 14 sunscreens. Is mentioned as "generally not used" by the cosmetics industry.	REACH: Laboratory chemicals. perfume, fragrances, pharmaceuticals, photo-chemicals, cosmetics, personal care products SPIN: Notified, but no information on applications
HMS	118-56-9	Cosmetics, in the present study found in face cream; body wash; cream; day cream; eau de toilette; foundation; hand cream; lip balm; makeup; perfume; sun oil; sun screen. Found in 27 products out of 291, including 18 sunscreens. Homosalate (HMS) is used by a single company in the cosmetics industry (out of respondents)	REACH: cosmetics and personal care products SPIN: No uses
OC	6197-30-4	Cosmetics, in the present study found in face cream; foundation; hand cream; lip balm; makeup; nail polish remover; sun oil; sun screen. Found in 76 products out of 291, including 53 sunscreens. Specified as "less used" by the cosmetics industry.	REACH: Cosmetics, personal care products, perfume, fragrances, coatings and paints, thinners, paint removes, fillers, putties, plasters, modelling clay, polymer preparations and compounds. SPIN: Notified, but no information on applications
OD-PABA	21245-02-3	Cosmetics, in the present study found in sunscreen; foundation. Found in 2 products of 291, including 1 sunscreen. Not mentioned as being used by the cosmetics industry. UV-curing printing inks and varnishes, printing inks for paper and cardboard packaging.	REACH: Pre-registered. SPIN: Notified, but no information on applications

1 As registered for Denmark in 2012 in the SPIN database as data from the Nordic Product Registers (http://195.215.202.233/DotNetNuke/default.aspx)

For BP-3, Table 19 shows that the substance is not one of the most widely used substances in cosmetic products on the Danish market. In addition, it appears that the substance can be found in other products that may lead to consumer exposure, including the use in plastics for food packaging. For 4-MBC it appears that the substance is probably not used in cosmetic products on the Danish market today, and other uses have not been identified in the survey. For OMC the industry has indicated that the substance is hardly used, but it is found in 59 products out of 291 products on the market, including 14 sun screens, as shown in Table 19. For HMS, it appears that the substance is used in cosmetic products on the market, although to a lesser extent than the OMC. There are no other uses of OMC and HMS in the survey. According to the table, OC is being used in cosmetic products on the Danish market, and in addition other uses of the substances, such as in paints, fillers, modelling clay and photo-chemicals have been registered under REACH. However, this is not further documented in the survey. OD-PABA has limited use as a UV filter in cosmetic products on the Danish market. The substance is furthermore found in UV curing printing inks and varnishes, which are used for paper and cardboard packaging. For the substances BP-3, 4-MBC, OMC, OD-PABA and OC it is evident from Table 20/the survey that the substances are found in drinking water, which therefore might be a source. No studies on the occurrence of the substances in Danish drinking water or surface water have been identified.

It should be noted that one of the purposes of the survey was to identify the sources of the UV filters that were found in the biomonitoring studies, but that it is outside the scope of the project to identify other UV filters and UV absorbers (and their metabolites) which would be appropriate to include in such studies.

2.6 Summary of the survey

The survey is based on information from the Internet, scientific literature, available information from REACH registrations, non-confidential data from the Danish Product Register and the SPIN database (professional use of raw materials and products containing UV filters and UV absorbers) and from market players contacted directly or through their respective industry associations. The participating market players cover suppliers of raw materials, compounders and suppliers of preparations and articles.

BASF, Addivant and Clariant are the primary producers of UV filters and UV absorbers in Europe, and they manufacture raw materials for the cosmetics industry and for other purposes, such as plastics and polymers.

Cosmetics

Inquiries to suppliers of cosmetics on the Danish market resulted in relatively limited feedback. The information obtained suggested, however, that it was a limited amount of the permitted UV filters that were actually used. Compared to those UV filters found during biomonitoring (see section 2.5.2), it applies that benzophenone-3 (BP-3), 4-methylbenzylidenecamphor (4-MBC) and ethylhexyl dimethyl PABA (OD-PABA) were not mentioned as being used by the cosmetics companies organised in SPT, who answered the survey questions. Homosalate (HMS) is used by a single company and octocrylene (OC) is indicated as "less used" and ethylhexyl methoxycinnamate (OMC) as "virtually no use".

To complement the information received from market players, 11 shops were visited. The ingredient lists of those products that were expected to contain UV protection, and a number of other products were reviewed. The review showed that UV filters and especially UV absorbers were found in many different types of cosmetic products, as well as products which are not expected to be significantly affected by sunlight. Examples are mouthwash and makeup remover. The explanation may be that several of the absorbers also have other functions, including masking undesirable odours from the products.

The shop visits showed that among the 291 products identified as containing substances that can act as UV filters or UV absorbers, most of the products contained:

- Butyl methoxydibenzoylmethane (BDMBM), CAS No. 70356-09-1 (119 products),
- Titanium dioxide (incl. the nano form), CAS No. 13463-67-7 (91 products)
- Benzyl salicylate, CAS No. 118-58-1 (87 products),
- Ethylhexyl salicylate, CAS No. 118-60-5 (84 products),
- Octocrylene (OC), CAS No. 6197-30-4 (76 products) and
- Ethylhexyltriazone, CAS No. 88122-99-0 (73 products).

The most frequently occurring substance, butyl methoxydibenzoylmethane (CAS No.70356-09-1), was also identified among the most abundant substances in a previous survey of UV filters in sunscreens from 2002 (Rastogi, 2002). The substance benzyl salicylate probably is most likely used as a fragrance in most of the products.
Among the 291 products, the group of sun screens contained the highest number of different UV-protective substances. A total of 24 substances were represented in this group. The group of face creams contained 16 different UV-protective substances and foundation contained 17 different ones.

Some of the substances may, as previously mentioned, be added to provide a function other than that as UV-filter/UV absorber.

Textiles
Regarding textiles, the survey suggests that the use of UV filters primarily is associated with textiles for the automotive industry, awnings and outdoor textiles. Regarding clothes on the Danish market, the immediate feedback from market players was that UV protection is achieved through garment weaving. However, it has generally been difficult to obtain information as the suppliers often have to go far back in the supply chain in order to retrieve the information.

It was not possible to get information about the content in chemical products applied to textiles in order to achieve UV protection.

Toys
Regarding plastics, the survey among the market players gave the highest results for toys. Based on information from the European trade association for toys, TIETOY, it appears that UV-protective substances have the highest usage in indoor plastic toys. According to industry, benzophenone-12 (CAS No. 1843-05-6) is one of the substances found in the highest concentration, namely 5,2%. A substance, such as fluorescent brightener 367 (CAS No. 5089-22-5), however, also occurs in concentrations of 5% in plastic parts. It is also stated that benzophenone (CAS No. 119-61-9), which is a photo initiator, may be included at levels of up to 1.4% in the varnish of indoor plastic toys and 2,2-dimethoxy-2-phenylacetophenone (CAS No. 24650-42-8) can be included at levels of up to 10% in printing ink.

There is no information on the possible content in finger paints and modelling clay.

Other articles of plastics and other polymers
Feedback from suppliers of outdoor plastic products, including both furniture and play equipment such as plastic slides and swings, was that there were no used UV-protective substances of the type covered by the present project, but rather stabilisers based on different mechanisms of action. The substances listed as being used in plastic toys, are, however, probably also used in plastics for other applications.

Food packaging
UV-absorbers and UV filters are added to food packaging to protect the packaging itself and the contained food from harmful UV light. It has been shown that these substances are able to migrate to food and beverages. Studies have demonstrated a wide range of UV filters or UV absorbers present in PET bottles including benzophenone-1 (CAS No. 131-56-6) and benzophenone-3 (CAS No. 131-57-7) in packaging of various other types of plastic.

It has not been possible though inquiries to market players or laboratories to confirm the use of UV protective substances in food packaging (for example, in PET bottles) in Denmark.

Paints, varnishes, adhesives, sealants
Various benzophenone derivatives (including benzophenone-3 and benzophenone-12) and benzotriazoles are the UV filters that are registered in the largest quantities in paints and varnishes in the Danish Product Register, according to the SPIN database. This is confirmed by information obtained through The Danish Paints and Adhesives Industry. According to information from the industry, the UV-protective substances are present in paints and varnishes in concentrations of between 0.1 and up to 3% - the highest concentrations reported in outdoor wood oil/wood protection. UV stabilizers are included in assembly adhesives in concentrations of 0.1 to 0.25%, and in sealants in concentrations from 0.04 to 0.25%. These are typically UV filters, which are only used in these types of products.

Printing ink
A single manufacturer of printing inks has informed the authors that UV absorbers are only used for two applications:

- For industrial products to be used outside - for example, road signs - UV absorbers of the Tinuvin® (benzotriazole) type are typically used.

- For UV-curing inks and varnishes, where the substances act as photo initiators (UV-curing agents), a number of substances are being used, including benzophenone and benzophenone derivatives.

Materials with prints containing 4-methylbenzophenone or benzophenone should not come in contact with food, unless the company can demonstrate that the total amount of 4-methylbenzophenone and benzophenone migrating to the food is below 0.6 mg per kg foodstuff.

Cleaning products and detergents
Neither of the two companies contacted during the survey used UV-protective substances in their products. There was no information available on whether there could be other producers using UV filters and UV absorbers in detergents, or which substances could be used. For some of the substances (as shown in Appendix 3) detergents are included as one of the registered product categories (PC35), but this cannot with certainty be interpreted as they are actually used for this purpose. Based on this, it cannot be excluded that UV filters are being used in cleaning products and detergents on the Danish market, but it does not seem to be widespread.

Correlation between the results of the survey and the substances found by biomonitoring, in drinking water, surface water and biota
The results of the survey are summarized in Table 20 together with information about which of the substances are found in biomonitoring studies, drinking water, the aquatic environment and biota. The table is organized so that:

- Substances found in biomonitoring studies are indicated at the top of the table, the other substances are indicated in the following order:
  - Other substances found in drinking water;
  - Other substances found in the aquatic environment and biota;
  - Other substances used in cosmetics;
  - All other substances.

All substances are only mentioned once. Only substances for which specific information has been found as part of either the survey or in the literature are included in the table. This means that UV absorbers from the CosIng database (Appendix 3) or UV filters permitted in cosmetic products (Appendix 1) are not included in the table if no additional information about the use of the substances has been found. Furthermore, the table does not include uses that are only indicated as chemical product categories (PC) in REACH registrations and not otherwise identified. The substances are listed in alphabetical order within the overall grouping. The division is selected in order to provide an overview and support the following discussion. The delimitations in relation to data sources are made so that focus will be to applications where there is reasonable certainty that the substances are actually used for the given application. Further information about the chemical name (IUPAC names) and registration status of all substances are listed in Appendix 4.

Substances found in biomonitoring - A more detailed overview of possible sources of substances found in biomonitoring studies is given in Table 19 and discussed in connection with this table. A single substance found in biomonitoring studies (4-MBC), which is included in Table 19, is not identified in the survey. Rastogi (2002) indicates, however, that the substance is used in cosmetics, but the results from the shop survey indicate that the substance is probably not used in

cosmetic products on the Danish market today. The other five substances found in biomonitoring studies are all identified in cosmetic products, which may be because substances used in cosmetics are the substances included in the biomonitoring studies. Three of the substances (OD-PABA, OMC and HMS) are only found in cosmetics in this survey. As shown in Table 19 the substances are being used in a wide range of cosmetic products and their use is not limited to sunscreens and other cosmetic products, where there is a particular need for sun protection, and where a seasonal use of the products is to be expected. According to the survey, two of the substances (BP-3 and OD-PABA), which are also found in drinking water and in the environment, are both used in paint/varnish, in plastics (only BP-3), and in printing inks (only OD PABA). These other uses may be expected to contribute to the exposure of humans. The lack of detection of the other UV filters that are used in the biomonitoring studies may be due to the fact that investigations have generally only covered substances used in cosmetics, as for example is the case with the substances studied by Schlump et al. (2010).

Substances found in drinking water – The substances that are found in biomonitoring studies are also generally found in drinking water and in the environment (apart from HMS, for which there are no data on presence in drinking water). The investigated drinking water is in all cases derived from surface water (lakes and rivers) which is generally not used for drinking water in Denmark. In addition to the substances found in biomonitoring studies, BP is found in drinking water. The substance is not found in cosmetics in this survey and is not among the substances permitted for use as UV filters in cosmetics. On the other hand, it is widely used in plastics (including plastic toys and food packaging), paint/varnish and printing inks (including food packaging).

Substances found in the environment - In addition to the six substances found in biomonitoring studies, five substances have been detected in the aquatic environment and/or biota. Of these other substances, one substance, BMDBM, is used in cosmetics. This substance was the most frequently occurring substance in the survey of cosmetic products. Furthermore, it is identified as used in toys. However, with the frequent occurrence in cosmetics, it is most likely that it is the use in cosmetics which gives rise to the presence of the substance in the aquatic environment. The other substances (UV-234, UV-328, UV 327 and UV-329) are not found in cosmetics and are not approved as UV filters in cosmetics. They are all used in plastics (some of the substances are indicated as being used in plastic toys and food packaging as well) and two of the substances are also identified as used in paint and varnish. As mentioned in section 2.5.1, these substances mainly end up in the environment via waste water and sludge. The fact that these substances, which are not used in cosmetics, can be found in the aquatic environment and biota indicate that other UV protective substances may be possible to find in the environment, if one analysed for them.

Other substances - For most of the substances that are used in cosmetics, no other applications have been identified. However, there are also a number of other substances, which are used both in cosmetics and in other types of products: benzophenone-1, benzophenone-4, benzotriazolyl dodecyl p-cresol, butyl methoxydibenzoylmethane, titanium dioxide and zinc oxide. For the other substances not used in cosmetics, the uses show a more mixed picture, with benzophenones apparently being the most widely used substance.

TABLE 20

SUMMARY OF IDENTIFIED USES OF UV FILTERS AND UV ABSORBERS AS WELL AS FINDINGS OF SUBSTANCES IN BIOMONITORING, DRINKING WATER, THE AQUATIC ENVIRONMENT AND BIOTA. L = FOUND IN THE LITERATURE, B = FOUND IN THE SHOP VISITS IN 11 SELECTED STORES, M = IDENTIFIED AS BEING USED BY QUESTIONED MARKET PLAYERS AND W = INFORMATION FROM THE PRODUCERS' AND SUPPLIERS' WEBSITES.

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
4-Methylbenzylidene camphor	4-Methylbenzylidene camphor	36861-47-9	253-242-6	A	4-MBC	L	L	L	L								
Benzophenone-3	Benzophenone-3	131-57-7	205-031-5	A	BP-3	L	L	L	B; L		L; W		L	L			
Ethylhexyl Dimethyl PABA	Ethylhexyl Dimethyl PABA	21245-02-3	244-289-3	A	OD-PABA	L	L	L	B				M		L	M	
Ethylhexyl methoxycinnamate	Ethylhexyl methoxycinnamate	5466-77-3	226-775-7	A	OMC	L	L	L	B; L; M								
Homosalate	Homosalate	118-56-9	204-260-8	A	HMS	L		L	B; L; M								
Octocrylene	Octocrylene	6197-30-4	228-250-8	A	OC	L	L	L	B; L; M								
Benzophenone	Benzophenone	119-61-9	204-337-6		BP		L					M	L	L	L	M	
Butyl methoxydibenzoylmethan	Butyl methoxydibenzoylmethan	70356-09-1	274-581-6	A	BMDBM			L	B; M; L			M					
2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol	-	70321-86-7	274-570-6		UV-234			L			M	M					
2 - (2H -Benzotriazol -2-yl) -4,6- di-tert- pentylphenol	2-(2'-Hydroxy-3',5'-di-t-amylphenyl) benzotriazol	25973-55-1	-		UV-328			L			L; W		W				
2-(5-chloro-2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-propanyl)phenol	-	3864-99-1	223-383-8		UV-327			L			W		W	L			
Octrizole	-	3147-75-9	221-573-5		UV-329			L			L; W	M					

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
3-Benzylidene camphor[20]	3-Benzylidene camphor	15087-24-8	239-139-9	A	3-BC				L								
Benzophenone-1	Benzophenone-1	131-56-6	205-029-4		BP-1				B; W	L	W			L			
Benzophenone-2	Benzophenon-2	131-55-5	205-028-9						L								
Benzophenone-4	Benzophenone-4	4065-45-6	223-772-2	A	BP-4				B; W	L; W			W				
Benzotriazolyl dode-cyl p-cresol	Benzotriazolyl dodecyl p-cresol	125304-04-3	*603-051-2						B		L						
Benzyl salicylate	Benzyl salicylate	118-58-1	204-262-9						B; L								
Bis-ethylhexyloxyphenol methoxyphenyl triazine	Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	-	A	BEMT				B; M								
Camellia sinensis leaf extract	Camellia sinensis leaf extract	84650-60-2	283-519-7						B; L								
Diethylamino hydroxybenzyol hexyl benzoate	Diethylamino hydroxybenzyol hexyl benzoate	302776-68-7	443-860-6	A					B; L; M								
Diethylhexyl butamido triazone	Diethylhexyl butamido triazone	154702-15-5	*604-972-2	A					B; M								
Drometrizole trisiloxane	Drometrizole trisiloxane	155633-54-8	*919-634-2	A					B								
Ethyl ferulate	Ethyl Ferulate	4046-02-0	223-745-5						B								
Ethylen/methacrylate copolymer		-							B								
Ethylhexyl salicylate	2-Ethylhexyl salicylate	118-60-5	204-263-4	A					B; M								
Ethylhexyl triazone	Ethylhexyl triazone	88122-99-0	402-070-1	A					B; M								
Isoamyl p-	Isoamyl P-	71617-10-2	275-702-5	A					B								

[20] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
methoxycinnamate	methoxycinnamate																
Methyl salicylate	Methyl salicylate	119-36-8	204-317-7						B								
Methylen bis-benzotriazolyl tetramethylbutyl-phenol	Methylen bis-benzotriazolyl tetramethylbutyl-phenol	103597-45-1	403-800-1	A					B								
Phenylbenzimidazole sulfonic acid	Phenylbenzimidazole sulfonic acid	27503-81-7	248-502-0	A					M; B								
Polysilicone-15	Polysilicone-15	207574-74-1	*606-621-9	A					M; B								
Terephthalylidene dicamphor sulfonic acid	Terephthalylidene dicamphor sulfonic acid	92761-26-7 / 90457-82-2	410-960-6	A					B								
Titanium dioxide (inkl. the nano form)	Titanium dioxide, CI 77891	13463-67-7	236-675-5	A					B; L; M	W; L	L	M					
Triethoxy caprylylsilane	Triethoxycaprylylsilane	2943-75-1	220-941-2						B								
Trimethoxy caprylylsilane	Trimethoxycaprylylsilane	3069-40-7	221-338-7						B								
Tris (tetramethylhydroxy-piperidinol) citrate	Tris (tetramethylhydroxypiperidinol) citrate	220410-74-2	429-370-5						B								
Vitis vinifera seed extract	-	84929-27-1	284-511-6						B								
Zink oxide	Zinc oxide	1314-13-2	215-222-5						B; L	W	L	M	M				
A mixture of: isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-(n)-dodecylphenol; isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-(n)-tetracosylphenol; isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-5,6-didodecyl-phenol. n=5 or		23328-53-2 / 125304-04-3 / 104487-30-1	401-680-5								L						

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
6																	
2-(2H-benzotriazol-2-yl)-p-cresol	Drometrizole	2440-22-4	219-470-5								L; M; W	M	W; L	L			
2-(2'-Hydroxy-3',5'-di-tert-butylphenyl)-5-chlorobenzotriazol	-	3864-99-1	223-383-8								W			L			
2-(4,6-Diphenyl-1,3,5-triazin-2-yl)-5-[(hexyl)oxy]-phenol	-	147315-50-2	*604-583-8											L			
2,2-Dimethoxy-2-phenylacetophenone	Phenyldimethoxyacetophenone	24650-42-8	246-386-6									M	L		L	M	
2,4-bis(1,1-dimethylethyl)-phenol, phosphit (3:1)	-	31570-04-4	250-709-6									M					
2-benzotriazol-2-yl-4-(2,4,4-trimethylpentan-2-yl)phenol	-	52188-76-8	-											L			
2-Benzotriazol-2-yl-4,6-di-tert-butylphenol	-	3846-71-7	223-346-6		UV-320						L						
2-hydroxybenzophenone	-	117-99-7	204-226-2							L							
2-Isopropylthioxanthone	-	5495-84-1	226-827-9		ITX								L	L	L		
2-Propenoic acid, 2-cyano-3,3-diphenyl-, ethyl ester	Etocrylene	5232-99-5	226-029-0								L						
3-glycidyloxypropyltrimethoxy silane type	-	ikke angivet											M				
4-(4-Methylphenylthio)benzophenone	-	83846-85-9	281-064-9												L	M	
4,4'-Dihydroxybenzophenone		611-99-4	210-288-1											L			

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
4-Aminobenzoic acid	PABA	150-13-0	205-753-0											L			
4-Aminophenyl-1H-benzimidazol-5-sulfonic acid		ikke angivet								L							
4-Benzoylbiphenyl	-	2128-93-0	218-345-2		PBZ									L	L	M	
4-hydroxybenzophenone	-	1137-42-4	214-507-1		HBB									L	L		
4-Methylbenzophenone	Methyl benzophenone	134-84-9	205-159-1		4-MBP								L		L		
alpha-3-[3-(2H-banzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1-omega-hydroxy-poly(oxyethylene) and alpha-3-[3-(2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1- omega-3-(3-(2H-benzotriazol-2-yl)-5-t-butyl-4- hydroxyphe-phenyl)propionyloxypoly(oxyethyl)	-	ikke angivet											M				
Benzophenone-12	Benzophenone-12	1843-05-6	217-421-2		BP-12						L; W	M	L				
Benzophenone-6	Benzophenone-6	131-54-4	205-027-3							L							
Benzophenone-8	Benzophenone-8	131-53-3	205-026-8								L		M				
Bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate	-	41556-26-7	255-437-1										M				
Bis(1,2,2,6,6-pentamethyl-4-piperidyl) [[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]bu	-	63843-89-0	264-513-3										M				

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
tylmalonate																	
A mixture of branched and linear C7-C9 alkyl 3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]propionates	-	127519-17-9	407-000-3										M				
Bumetrizole	Bumetrizole	3896-11-5	223-445-4							L	M; W		L; M	L			
Butanedioic acid, 1,4-dimethyl ester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol	-	65447-77-0	*613-797-0									M	M				
Cerium oxid nano particle	-	11129-18-3	234-374-3										M				
Dimethyl 2-[(4-methoxyphenyl)methyliden] propanedioat	-	7443-25-6	231-185-8								L; W						
Dispersion of ceriumoxid	-	346608-13-7/90622-58-5	-/292-460-6										M				
Docusate sodium	Diethylhexyl sodium sulfosuccinate	577-11-7	209-406-4										M				
Ethoxylated ethyl-4-aminobenzoate	Ethoxylated ethyl-4-aminobenzoate	116242-27-4	.	A									M			M	
Ethyl 4-dimethylaminobenzoate	Ethyl Dimethyl PABA	10287-53-3	233-634-3												L	M	
Fluorescent brightener 367	Fluoroscent brightener 367	5089-22-5	225-803-5									M					
Hydroxyphenyltriazine	-	153519-44-9	*604-910-4							L			M				
Methyl-1,2,2,6,6-pentamethyl-4-piperidylsebacate	-	82919-37-7	280-060-4										M				

Chemical name used in the report	INCI name	CAS No.	EC Nr.	Approed UV filter(A)	Abbreviation	Biomonitoring	Drinking water	Aquatic environment and biota	Cosmetics	Textiles	Plastic	Toys	Paint, coatings and oils	Food packaing	Printing inks for food packaging	Printing inks, other	Cleaning agents and detergents
N-(2-ethoxyphenyl)-N'-(2-ethylphenyl)oxamide	-	23949-66-8	245-950-9								L; W		M				
Octrizole	Octrizole	3147-75-9	221-573-5								L	M	W				
Pentamethyl piperidyl sebacate type	-	ikke angivet											M				
Phenol, 2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)-phenol	-	70321-86-7	-								W			L			
Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy-	PEG	25322-68-3	500-038-2								L		M				
Poly(oxy-1,2-ethanediyl), α-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-ω-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropoxy]-	.	104810-47-1	*600-602-9								L		M				
Poly(oxy-1,2-ethanediyl), α-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-ω-hydroxy-	.	104810-48-2	*600-603-4								L		M				
Tetraethyl 2,2'-(1,4-phenylendimethylidyn) bismalonat	-	6337-43-5	228-726-5								W						

3. Preliminary exposure assessment and selection of substances

3.1 Potential for exposure through consumer products

Table 21 presents a preliminary assessment of the potential for exposure of consumers via products that may contain UV filters and/or UV absorbers. The assessment was made in the project's start-up phase to support the focus of the survey and has since been revised. The potential for exposure was screened based on the identified application areas and an assessment of the potential for direct exposure.

Exposure can occur through direct contact with mixtures or by contact with articles, where the substances potentially can be released by migration or to indoor air via evaporation. The potential for exposure is generally assessed as higher if the exposure is direct and can be frequent and less high in other cases where the substances must migrate out of a solid matrix. In addition, it may be relevant to consider any legislation that supports a limitation of exposure, as in the case with food contact materials where the migration of hazardous substances is regulated.

The potential for exposure from cosmetics applied directly to the skin, as well as e.g. paint, which during use can cause direct contact with the skin, is generally assessed as higher. The frequency of exposure will vary and may be considered to be substantially higher for cosmetics than for paint, which is used less frequently, but may give rise to a temporary high exposure. Exposure is dependent on conditions such as temperature, migration fluid, etc.

The table also lists import data from Statistics Denmark for the relevant product groups. Since the proportion of the product groups containing UV filters and UV absorbers it is not known, the information only provides a rough indication of where the big volumes are available. An attempt has been made to organize the list according to potential exposure, where products with an expected high potential are listed first.

TABLE 21
POSSIBLE CONSUMER EXPOSURE FROM USE OF PRODUCTS WITH UV-FILTERS AND UV-ABSORBERS

Application	Data from Statistics Denmark	Route of exposure / comment
Cosmetics	33049900 Beauty or make-up preparations and preparations for the care of the skin (other than medicaments), including sunscreen or suntan preparations; manicure or pedicure preparations: Net imports in 2012: 3,480 tonnes (trade package included)	Direct and intentional contact with the skin. The products are mixtures. The products are used frequently.
Paints for walls, ceilings, woodwork and metals under indoor conditions	32081090-32089091+32100010: Paint and varnishes non aqueous media: supply 2012: 17,586 tonnes	Skin contact during application, inhalation of aerosols.

Application	Data from Statistics Denmark	Route of exposure / comment
Paints for walls, ceilings, woodwork and metal under outdoor conditions	32091000-32099000: Paint and varnishes non aqueous media: supply 2012: 38,486 tonnes	The products are mixtures. The products can be used frequently. Contact not intentional but may be difficult to avoid without the use of protective equipment.
Paint / coatings for boats and yachts etc.	Not separately registered	
Protective oils for wood under outdoor conditions	Not separately registered	
Adhesives	35069100-35069900: Adhesives – supply 2012: 10249 tonnes	Risk of skin contact, possibly inhalation. Skin contact during application, inhalation of aerosols. The products are mixtures. The products can be used frequently. Contact not intentional but may be difficult to avoid without the use of protective equipment.
Sealants (buildings etc.)	3214101000 Sealants and fillers etc.: Danish production 2012: 5424 tonnes Net imports 2012: -1243 tonnes Supply: 4,181 tonnes	
Clothing designed for outdoor use including swimwear and sports equipment	61123110 – 61124990 Swimwear: net imports in 2012: 291 tonnes 61011010-62029900: anoraks, overcoats etc.: net imports in 2012: 4,158 tonnes	Direct contact with skin and material. The products are articles. Migration can occur from clothes in direct contact with the body. The products are used frequently periodically (seasonal).
Clothing designed to avoid fading	No data – not defined in the statistics	
Contact lenses	90013000 Contact lenses: net imports 2012: 268 tonnes	Direct contact with skin and mucous membranes. The products are articles. Migration may occur. The products are used frequently.
Air mattresses and sports equipment, etc.	63064000 Air mattresses: net imports 2012: 290 tonnes 95069990 Articles and equipment for general physical exercise, gymnastics, athletics, other sports or outdoor games, not specified or included elsewhere; swimming pools and paddling pools Net imports 2012: 4,904 tonnes	Direct contact with skin and material. The products are articles. Migration may occur. The products can be used frequently periodically (seasonal).
Plastic accessories like sunglasses, bracelets and watchbands	90031100 Frames and mountings of plastic for spectacles, goggles or the like, and parts thereof: net imports 2012: 28 tonnes 90041091 Sunglasses with lenses of plastic: net imports 2012: 80 tonnes	
Plastic and rubber footwear (sandals, rubber boots, etc.).	64019900 -64029999: Footwear with plastic/rubber soles and uppers of plastic: net imports 2012: 3,539 tonnes	

Application	Data from Statistics Denmark	Route of exposure / comment
Toys and play equipment		Direct skin contact with the material and the risk of evaporation to indoor environments. The products are articles. Migration may occur. The products are used frequently.
Plastic parts for indoor use designed to avoid fading (e.g. floors, handles, electrical cables and wires, etc.)	Not separately registered	Possible direct contact with skin or risk of evaporation to indoor environments. The products are articles. Migration and evaporation can occur. Frequent contact possible.
Textiles designed for outdoor use including furniture (e.g. pillows), deck chairs, etc.	63062100 – 63062900 Tents: net imports 2012: 1,049 tonnes 63069000 Camping goods of textile materials: net imports: 2012: 621 tonnes 63063000 Sails: Danish production + net imports: 124 tonnes 66011000 – 66019990 Umbrellas and sun umbrellas: net imports in 2012: 1,882 tonnes (only partially textile) Cushions and pillows are not registered separately	Possible direct contact with the skin. The products are articles. Migration may occur. The products can be used frequently periodically (seasonal).
Textiles for cars and the like	Not separately registered	Possible direct contact with skin or risk of evaporation to indoor environments The products are articles. Migration may occur. The products are used frequently.
Textiles for interiors designed to avoid fading (e.g. furniture, carpets, curtains, etc.).		
Plastic furniture for outdoor use (e.g. garden furniture)	94018000 Seats (presumably plastics): net imports 2012: 2006 tonnes 94037000 Furniture of plastics (excluding seats): net imports 2012: 2,612 tonnes	Possible direct contact with the skin and the risk of evaporation to indoor environments. The products are articles. Migration may occur. The products can be used frequently periodically (seasonal).
Plastic furniture for indoor use incl. furniture covered with laminated fabrics (PVC, PU)	Not registered separately - are included in the figures for outdoor furniture	
Pulp and paper (books, print)		Direct skin contact or risk of evaporation to indoor environments. The products are articles. Migration may occur. The products are used frequently.
Plastic film and trays etc. for packaging of meat, fish, vegetables, nuts etc.	Not separately registered	Ingestion, skin contact. The products are articles. Migration may occur. Migration is regulated by

Application	Data from Statistics Denmark	Route of exposure / comment
Paper and cardboard packaging for sugar, flour etc.	1701991000 White sugar excl. flavoured or coloured, dry state: Danish production 2012: 262, 000 tonnes. Weight of packaging: 16 g/2 kg sugar ~2,100 tonnes paper. 11010015 Flour of common wheat and spelt: Danish production and net imports: 264,000 tonnes: weight of packaging ~ 2,100 tonnes Is undoubtedly overestimated, as figures for flour and sugar also covers consumption for industrial production. In turn, the packaging of many products is not included. The weight of the packaging is estimated.	both the general provisions for all contact materials and specific provisions for migration from plastic. The products are used frequently.
Plastic bottles for beverages (beer, soft drinks, juices, mineral water, etc.).	PET bottles for soft drinks and mineral water: 2009-data: 206 million units in the return system of 53 g + 308 million disposable units of 20 g. A total supply of 17,080 tonnes PET per year. [Bryggeriforeningen 2009.]	
Plastic / polymer parts in automobiles and the like	Not separately registered	Possible direct skin contact (limited area) or risk of evaporation to indoor environments. The products are articles. Migration may occur. The products can be used frequently.
Coatings for automobiles, motorcycles, bicycles and related equipment	Not separately registered	
Tarpaulins and other articles based on coated fabrics	63061100-63061900 Tarpaulins, awnings and sun blinds: net imports 1,845 tonnes	Possible direct skin contact and risk of evaporation to indoor environments. The products are articles. Migration and evaporation can occur. Limited contact and Building up of indoor exposure.
Transparent plastic for roofing (for carports, covered patios, etc.).	Not separately registered	
Plastic doors and windows	39252000 Doors, windows and their frames and thresholds for doors of plastic: Danish production + net imports 2012: 2,688 tonnes	
UV protecting films and coatings (eg. to protect works of art and furniture).	Not separately registered	
Garden hoses	39173900 Flexible tubes, pipes and hoses, having a minimum burst pressure of 27,6 MPa (assumed to correspond to garden hoses): net imports 2012: 1,056	Possible direct skin contact with the material. The products are articles. Migration may occur. The products can be used frequently.
Agricultural film (packaging)	Not separately registered	
Enclosures for electrical and electronic equipment (household machines, radio, TV and music equipment, phones and tablets)	Not separately registered	
Glazing, windscreens	Not separately registered	limited exposure In some cases direct contact with skin. The products are articles. Migration may occur. Not frequent contact.
Roofing membranes	Not separately registered	
Roofing materials (other than plastic)	Not separately registered	

Application	Data from Statistics Denmark	Route of exposure / comment
Photographic equipment		Frequent contact possible.
Geotextiles	Not separately registered	Buried in the ground - hardly any exposure.
Optical fibres		

The table shows that there are very large volumes associated with paints, varnishes, adhesives and sealants, where a high exposure of professional users can be expected during application of the products, and where the frequency of use may be high for some users, but would likely be low for the majority of the consumers. Consumers would likely get in contact with the products during application, both by direct skin contact with the product and by inhalation of aerosols, if the product is applied by spraying. Paints, fillers and coatings applied indoors may also result in evaporation of substances, which may end up as components in house dust. Painting is also likely to be one of the applications which may give rise to environmental exposure through wastewater.

All products in the form of articles may give rise to contact with UV filters and UV absorbers, if the substances migrate from the materials and / or evaporation occurs from the products. Some substances may also be dispersed into the environment during use or in the disposal phase and result in additional exposure via e.g. drinking water or during recreational activities in lakes, rivers and coastal waters. Consumers may also be exposed to substances migrating from food contact materials into the food that is subsequently ingested. Articles in use in indoor environments can also contribute components to dust formation, causing exposure via indoor air.

3.2 Exposure to UV filters and UV absorbers investigated in consumer projects

To supplement the survey with additional information about the possible exposures, research was carried out to determine whether UV filters had been analysed in previous Danish consumer projects. A search of the Environmental Protection Agency database of the Danish surveys of chemical substances in consumer projects (http://www2.mst.dk/databaser/Vidensbank) did not produce any results. A manual review of 15 consumer projects[21] on textiles, spray products and textile paints, toys, baby and children's products, spray paint, sealants and printed matter showed that UV filters are generally not investigated.

A consumer project on cosmetic products for children (Poulsen and Schmidt, 2007) mapped the ingredients of a total of 208 cosmetic products for children and the results were compiled into a database. Organic UV filters and UV absorbers found in this project are shown in Table 22. The substances were found in bath confetti, conditioner, body lotion, body shampoo / bath gel and shampoo. Sunscreens, baby products, and "decorative" cosmetics (nail polish, make-up) were not covered by this project, and therefore the results do not provide a complete picture of the occurrence of UV filters and UV absorbers in cosmetic products used by children.

The substances are not the same as those found in human biomonitoring studies, but they do indicate that children can be exposed to UV filters through other cosmetic products than sunscreens.

[21] Including consumer product no. 113, 2011; 98, 2008; 58, 2005; 70, 2006; 67, 2006; 93, 2008; 90, 2008; 45, 2004; 38, 2004; 36, 2003, 68, 2006; 88, 2007 og 46, 2006. (In Danish)

TABLE 22
UV FILTERS FOUND IN A CONSUMER PROJECT ON COSMETIC PRODUCTS FOR CHILDREN (POULSEN AND SCHMIDT, 2007). SUNSCREENS, BABY PRODUCTS, AND "DECORATIVE" COSMETICS (NAIL POLISH, MAKE-UP) WAS NOT COVERED BY THE SURVEY.

Substance	CAS No.	In number of products	Average ranking*
Benzyl salicylate	118-58-1	20	12.4
Benzophenone-4	4065-58-1	4	11.0
Benzophenone-2	131-55-5	2	5.0

* Indicates the average position in the list of ingredients on the products. A low number will indicate that the substance belongs to the main ingredients, while a high number indicates that the substance is present in small concentrations.

In another consumer project on the release of chemical substances from tents and tunnels for children, it was found that some tents were described as treated with a UV-protective impregnation. The chemical nature of this impregnation was, however, not mentioned (Hansen et al., 2004).

In a British survey of sunscreens (products collected in the city of Dundee in 2010), a total of 337 products (316 sunscreens, 18 lip balms and 3 combination products) containing 19 different UV filters were identified. The most common filter was butyl methoxydibenzoylmethane (CAS no. 70356-09-1) which was an ingredient in 96.4% of the products. Other substances that occurred with a high frequency were octocrylene (CAS no. 6197-30-4), which occurred in 90.5% of the products and bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS no. 187393-00-6), which occurred in 58.5% of the products. Octocrylene is among the substances which have been identified in the human biomonitoring studies. Other substances also found in human biomonitoring studies include ethylhexyl methoxycinnamate (CAS no. 5466-77-3) which was found in 17.8% of the products, homosalate (CAS no. 118-56-9) which was found in 15.7% of the products, benzophenone-3 (CAS no. 131-57-7) found in 15.1% of products and 4 methylbenzylidene camphor (CAS no. 36861-47-9), which was found in 1.2% of products (Kerr, 2010).

3.3 Substances selected for environmental and health assessment

The results of the survey have been reviewed in order to select substances for environmental and health assessment, including exposure and risk associated with consumer exposure to the substances.

As mentioned in section 1.2, one of the project's goals was to help create a better understanding of the contribution from applications other than in cosmetics to the overall consumer exposure to UV filters and UV absorbers. Furthermore, it has been an objective to provide explanations for the presence of these substances in human urine and breast milk respectively, and in the environment, and to identify significant areas of data deficiency based on the project results. These objectives were considered in the selection.

The selection is therefore based on the survey results shown in Table 20, and an assessment of potential for exposure associated with different product types shown in Table 21.

All substances found in drinking water, the aquatic environment or biota were selected. Since some of the substances are also associated with knowledge or suspicion of endocrine disrupting effects in humans and aquatic organisms, these effects were also considered in the selection. At the same time, it should be emphasised that the presence of most of the substances included in this survey has not been studied in the environment or by human biomonitoring, and many of the substances are not assessed based on their potential for endocrine disrupting effects.

Overall, the following criteria were applied and substances matching one or more of the criteria were selected:

- Occurrence in the cosmetics identified by shop survey – in particular sun products
- Occurrence in human urine or breast milk
- Presence in drinking water
- Presence in aquatic environment or biota
- Potential endocrine disrupting properties
- The exposure from cosmetics is evaluated as high
- Presence in several other groups than cosmetics with direct or potentially high exposure (textiles, paints, food packaging).

Table 23 shows the list of the 19 substances prioritized for environmental and health assessment and their status in relation to the selection criteria.

The purpose of the environmental and health assessment within the framework of the present project is to use a common approach for the evaluation the substances on the basis of available sources.

TABLE 23
UV FILTERS AND UV-ABSORBERS SELECTED FOR ENVIRONMENTAL AND HEALH ASSESSMENT AND RISK ASSESSMENT

Substance	CAS No.	Found in sunscreen/sun oil	Found in other cosmetics*	Textiles	Plastics	Toys	Paint, varnishes, adhesives, fillers	Food packaging	Printing inks for food packaging	Printing inks, other	Cleaning products and detergents	Found in biomonitoring	Found in drinking water	Found in the aquatic environment and biota	Suspected endocrine disruptor
Benzophenone-3 / BP-3	131-57-7	B	B L		L W		L	L				L	L	L	√
Octocrylene / OC	6197-30-4	B	B L M									L	L	L	
Benzophenone-1 / BP-1	131-56-6		B W	L	W			L							√
3-(4'-Methylbenzylidene)-di-camphor / 4-MBC	36861-47-9		L									L	L	L	√
2-Ethylhexyl 4-(dimethylamino) benzoate / OD PABA	21245-02-3	B	B				M		L	M		L	L	L	
Titanium dioxide	13463-67-7	B	B L M	W L	L	M									
Butyl methoxy-dibenzoylmethane / BMDBM	70356-09-1	B	B M L			M								L	
Ethylhexyl salicylate	118-60-5	B	B M												
Ethylhexyl triazone	88122-99-0	B	B M												
Bis-ethylhexyloxyphenol methoxyphenyl triazine / BEMT	187393-00-6	B	B M												

Substance	CAS No.	Found in sunscreen/sun oil	Found in other cosmetics*	Textiles	Plastics	Toys	Paint, varnishes, adhesives, fillers	Food packaging	Printing inks for food packaging	Printing inks, other	Cleaning products and detergents	Found in biomonitoring	Found in drinking water	Found in the aquatic environment and biota	Suspected endocrine disruptor
Diethylamino hydroxybenzoyl hexyl benzoate	302776-68-7	B	B L M												
Diethylhexyl butamido triazone	154702-15-5	B	B M												
Ethylhexyl methoxycinnamate / OMC	5466-77-3	B	B L M									L	L	L	√
Homosalate / HMS	118-56-9	B	B L M									L		L	
Drometrizol trisiloxane	155633-54-8	B	B												
Terephthalylidene dicamphor sulfonic acid	92761-26-7	B	B												
Isoamyl p-methoxycinnamate	71617-10-2	B	B												
Benzophenone / BP	119-61-9					M	L	L	L	M			L		
Benzophenone-12 / BP-12	1843-05-6				L W	M	L								

*L = found in the literature, B = found in the shop visits in 11 selected stores, M = identified as being used by questioned market players and W = information from the producers' and suppliers' websites.

4. Environmental hazards and exposure

4.1 Introduction

This section is intended to provide a brief overview of the readily available information on environmental hazards associated with the 19 substances selected for screening. It is important to note that the information provided is based on the following, a limited number of readily available information sources, supplemented in some cases by other available assessments:

- The publicly available registration dossiers for the substance submitted under the EU REACH Regulation[22] (ECHA, 2014A). These are available on the website of the European Chemicals Agency (ECHA)[23]. They contain summaries of studies, many of them unpublished, submitted by industry in response to the standard data requirements of the REACH Regulation. Only data from key studies in the registration dossiers have been included.
- A report prioritising UV filters in cosmetics for environmental assessment (Environment Agency, 2008).
- The ECHA classification and labelling inventory (ECHA, 2014B). This provides information on the classification and labelling of the substances in the EU. These provide an indication of the environmental hazard for the substance. It should be noted that for most of the substances, multiple entries exist as suppliers have to notify the classification and labelling based on the information available to them. The classification and labelling have not been reviewed in detail for this report and so the most appropriate classification for each substance is not always apparent (although the number of notifications for each combination could be taken as a guide).

A comprehensive literature search has not been undertaken for this report and so it is likely that data other than that presented here could be available. In addition, it is important to note that none of the data have been validated as part of this project (see Section 4.2). In this respect, the evaluations presented should be seen as initial indicative assessments; a more in-depth evaluation of all the available data would be needed in order to confirm the hazards discussed.

For the assessment of the environmental hazards, the properties of the substances have been compared with the criteria given in Annex XIII of the REACH regulation, which are used to identify substances that are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB). Substances that possess these properties are generally considered to be hazardous to the environment. The PBT criteria are summarised below.

For a persistent, bioaccumulative and toxic (PBT) substance, the following criteria have to be fulfilled:

[22] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. OJEU L 396, 30.12.2006.

[23] http://echa.europa.eu/web/guest

- Persistent (P): a substance is considered to meet the P-criterion if a) the degradation half-life in marine water is >60 days, or b) the degradation half-life in fresh or estuarine water is >40 days, or the degradation half-life in marine sediment is >180 days or the degradation half-life in fresh or estuarine water sediment is >120 days, or the degradation half-life in soil is >120 days.
- Bioaccumulative (B): a substance is considered to meet the B-criterion if the bioconcentration factor in aquatic organisms is >2,000 L/kg.
- Toxic (T): a substance is considered to meet the T-criterion if the long-term no-observed effect concentration (NOEC[24]) or EC10[25] for marine or freshwater organisms is less than 0,01 mg/L. Note: the T-criterion also considers mammalian/human health data but the assessment here is based only on the environmental effects data.

For a very persistent and very bioaccumulative substance, the following criteria have to be fulfilled:

- Very Persistent (vP): a substance is considered to meet the vP-criterion if a) the degradation half-life in marine, fresh or estuarine water is >60 days, or the degradation half-life in marine, freshwater or estuarine water sediment is >180 days or the degradation half-life in soil is >180 days.
- Very Bioaccumulative (B): a substance is considered to meet the vB-criterion if the bioconcentration factor in aquatic organisms is >2,000 L/kg.

The Guidance to the REACH Regulation (ECHA, 2014C) also provides screening criteria that can be used to identify substances that are potentially PBT or vPvB and these have also been considered in the evaluation where relevant. This is particularly the case where only estimated data are available, and where data are not directly comparable with the definitive PBT criteria above.

It is important to note that the assessment for toxicity (T) carried out here only considers the available ecotoxicity data obtained from the standard ecotoxicity tests required by the REACH Regulation. The assessment does not consider the potential mammalian/human toxicity of the substances.

Since endocrine disruptive properties of substances in general give rise to a concern for both environment and human health, the description of possible endocrine disruptive properties is (if relevant) described in one separate section following the human health hazard evaluation of each substance in section 5 (Health hazard).

4.2 Data availability

Information on the environmental hazards is available for all of the UV filters and absorbers considered. However, the amount of information available varies from substance to substance and for most substances, experimental data that cover all relevant environmental endpoints have not been located. Therefore, the information on the environmental hazard is generally based on a mixture of experimental data and estimates, which by their nature introduce a degree of uncertainty into the evaluation (and in some cases it was not possible to carry out estimates for some parameters). In particular, there are generally only limited experimental data available for the long-term toxicity of the substances to aquatic organisms, bioconcentration factors in fish and to a lesser extent potential for biodegradation. As these endpoints are important for consideration of the environmental hazard of the UV filters, the use of estimates for these endpoints necessarily introduces some uncertainty into the conclusions drawn.

[24] NOEC = no observed effect concentration. This is the highest concentration tested that resulted in no significant effects in the exposed population compared with a control population.
[25] EC_{10} is the concentration that causes a 10% effect in the exposed population compared with the control population.

The data used in this evaluation (both experimental and estimates) have been taken at face value and have not undergone a detailed validation as part of this project. Some of the UV-filters have relatively high log Kow values (>6) and low water solubilities (<0.01 mg/L), and substances with these properties can be difficult to test in standard test systems (for example, bioavailability can be reduced in tests involving aqueous exposure owing to adsorption to vessels and/or particulate matter present in the test) which can introduce uncertainty into the experimental results obtained if these properties are not adequately taken into account in the test design. Similarly, some parameters, for example bioaccumulation potential, can be difficult to predict reliably for such substances.

4.3 Environmental hazard

4.3.1 Benzophenone-3 (Oxybenzone) (BP-3) (CAS No. 131-57-7)

A summary of the environmental fate and effects data for benzophenone-3 (BP-3) is presented in Table 24.

TABLE 24
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BENZOPHENONE-3 (BP-3)

Property	Description		Reference
Benzophenone-3 (Oxybenzone) (CAS No. 131-57-7)			
Physico-chemical data	Melting point	62.9°C	ECHA, 2014A
	Boiling point	>300°C	ECHA, 2014A
	Vapour pressure	0.0011 Pa at 25°C	ECHA, 2014A
	Log Kow	3.45	ECHA, 2014A
	Water solubility	6 mg/L at 25°C	ECHA, 2014A
Potential for degradation	Readily biodegradable Hydrolysis half-life at 25°C is 82.4 days at pH 4, 41.9 days at pH7 and 407 days at pH 9.		ECHA, 2014A
Bioaccumulation potential	Fish BCF = 36-158 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} = 3.8 mg/L for fish (*Oryzias latipes*). 48h-EC_{50} = 1.87 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} = 0.41 mg/L and 72h-NOEC = 0.18 mg/L for algae (*Pseudokirchneriella subcapitata*). No experimental data are available from standard long-term toxicity tests for fish and invertebrates but estimates obtained using the EPIWIN v3.12 program suggest a 30d-Chv of 0.57 mg/L for fish and a 21d-Chv of 0.42 mg/L for *Daphnia magna*.		ECHA, 2014A Environment Agency, 2008

Property	Description	Reference
Benzophenone-3 (Oxybenzone) (CAS No. 131-57-7)		
Environmental classification	No harmonised classification Notifications: Not classified (>900 notifications) Aquatic Chronic 2: H411 (169 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (26 notifications) Aquatic Chronic 1: H410 (5 notifications) Aquatic Acute 1: H400 Aquatic Chronic 2: H411 (2 notifications) Aquatic Chronic 4: H413 (1 notification)	ECHA, 2014B

Environmental fate and persistence

Benzophenone-3 has a water solubility of 6 mg/L at 25°C, an log octanol-water partition coefficient (log Kow) of 3.45 and a vapour pressure of 0.0011 Pa at 25°C (ECHA, 2014A). This combination of properties suggests that, although the substance is likely to adsorb onto soil and sediment to some extent, the substance may be relatively mobile in such media and subject to leaching and volatilisation.

The substance has been shown to undergo hydrolysis in laboratory experiments using the OECD 111 test guideline, but only at a relatively slow rate (ECHA, 2014A). The rate of hydrolysis is dependent on pH and the hydrolysis half-life at 25°C has been determined to be around 82.4 days at pH 4, 41.9 days at pH 7 and 407 days at pH 9.

The substance is readily biodegradable in the manometric respirometry test (EU Method C.4-D; ECHA, 2014A) and so is not likely to persist in the environment.

Bioaccumulation potential

The log Kow of benzophenone-3 (log Kow = 3.45) suggests a low potential for bioaccumulation. This is confirmed by an experimentally determined bioconcentration factor (BCF[26]) for the substance in fish of 36-158 L/kg. This test was carried out using the OECD 305 test guideline with an exposure period of 10 weeks and two exposure concentrations of 0.1 and 0.01 mg/L (ECHA, 2014A).

Ecotoxicity

Experimental data are available for the acute toxicity of benzophenone-3 to fish, aquatic invertebrates and algae. The lowest $L(E)C_{50}$[27] is 0.41 mg/L determined over 72 hours with algae. The 72 h-NOEC for algae is 0.18 mg/L (ECHA, 2014A). No experimental data are available for standard long-term toxicity of the substance to fish and aquatic invertebrates but estimates obtained using EPWIN v3.12 and reported in Environment Agency (2008) suggest chronic values (Chv[28]) of 0.57 mg/L for fish and 0.42 mg/L for *Daphnia magna*.

[26] The bioconcentration factor represents the steady state ratio of the concentration in the exposed organism to that in the water to which it was exposed.
[27] LC_{50} is the concentration that is lethal to 50% of the exposed population. EC_{50} is the concentration that causes a given effect in 50% of the exposed population. $L(E)C_{50}$ is an abbreviation representing both the LC_{50} and the EC_{50}.
[28] The chronic values or Chv's represent the geometric mean of the Lowest Observed Effect Concentration (LOEC) and the No Observed Effect Concentration (NOEC).

Evaluation

The available evidence suggests that the substance does not meet the REACH Annex XIII criteria for a PBT or vPvB substance, and this was concluded in the REACH Registration dossier for this substance. The substance is readily biodegradable and has a BCF <<2,000 L/kg.

4.3.2 Octocrylene (OC) (CAS No. 6197-30-4)

A summary of the environmental fate and effects data for octocrylene is presented in Table 25.

TABLE 25
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR OCTOCRYLENE **(OC)**

Property	Description		Reference
Octocrylene (CAS No. 6197-30-4)			
Physico-chemical data	Melting point	-10°C	ECHA, 2014A
	Boiling point	>300°C	ECHA, 2014A
	Vapour pressure	4.2×10^{-7} Pa at 25°C	ECHA, 2014A
	Log Kow	6.1	ECHA, 2014A
	Water solubility	<0.1 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable. Hydrolysis half-life estimated to be >> 1 year at 25°C using the Hydrowin v1.67 estimation program.		ECHA, 2014A
Bioaccumulation potential	Fish BCF = 915 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} >0.5 mg/L for fish (*Danio rerio*). 48h-EC_{50} > 0.023 mg/L for invertebrates (*Daphnia magna).* 72h-EC_{50} >200 mg/L and 72h-NOEC = 100 mg/L for algae (*Desmodesmus subspicatus*). No experimental data are available from standard long-term toxicity tests for fish and invertebrates but estimates obtained using the EPIWIN v3.12 program suggest a 32d-Chv of 8.9×10^{-4} mg/L for fish.		ECHA, 2014A Environment Agency, 2008 Blüthgen et al. (2014)
Environmental classification	No harmonised classification Notifications: Not classified (14 notifications) Aquatic Chronic 4: H413 (347 notifications) Aquatic Chronic 3: H412 (20 notifications) Aquatic Chronic 1: H410 (10 notifications)		ECHA, 2014B

Environmental fate and persistence

Based on its low water solubility (<0.1 mg/L at 20°C) and vapour pressure (4.2×10^{-7} Pa at 25°C) and high log Kow (log Kow 6.1) (values taken from ECHA, 2014A), octocrylene is expected to adsorb strongly onto sediment and soil and be relatively immobile in the environment.

The substance is not readily biodegradable in the manometric respiratometry test (EU Method C.4-D; ECHA, 2014A) and is predicted to be stable against hydrolysis in the environment (prediction obtained using the Hydrowin v1.67 program; ECHA, 2014A).

Bioaccumulation potential
The log Kow of 6.1 for octocrylene suggests a high potential for bioaccumulation; however, the BCF for the substance has been determined to be 915 L/kg in fish. The bioconcentration test was carried out using the OECD 305 test guideline with *Danio rerio* using exposure concentrations of 0.1 and 1 µg/L. The actual water solubility of octocrylene is not clear and so it is not known how these concentrations relate to the solubility limit of the substance in the test medium used.

Ecotoxicity
Experimental data are available on the short-term toxicity to fish, *Daphnia magna* and algae (ECHA, 2014A). These studies showed no acute toxicity at concentrations in excess of the water solubility of the substance, suggesting that the substance is not acutely toxic up to its water solubility limit in such tests. Similarly, the 72h-NOEC for algae was found to be 100 mg/L, which again is well in excess of the substance's water solubility.

No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems but estimates obtained using the EPIWIN v3.12 program reported in Environment Agency (2008) suggest that the long-term Chv for octocrylene in fish is around 8.9×10^{-4} mg/L.

Evaluation
The available information suggests that the substance potentially meets the REACH Annex XIII screening criteria for both P and vP, based on the fact that the substance is not readily biodegradable. Although the substance has a log Kow of 6.1 (and so potentially meets the Annex XIII screening criteria for B and vB), the BCF for the substance in fish has been determined to be 915 L/kg and so does not appear to meet the REACH Annex XIII criteria for B or vB based on this result. However, it is not clear whether or not the water solubility of the substance was exceeded in this test and so the study may warrant a more detailed evaluation.

The available short-term toxicity data suggest that the substance is not acutely toxic to aquatic organism at concentrations up to its water solubility limit; however, estimated data for long-term toxicity in fish suggests that the Annex XIII criteria for T could potentially be met.

Overall, the available information suggests that the substance does not meet the Annex XIII criteria for a PBT or vPvB substance; however, there are uncertainties relating to the BCF value and there are no long-term aquatic toxicity results. The REACH Registration dossier for this substance concludes that the substance does not meet the Annex XIII criteria. The substance is currently on the European Commission Rolling Action Plan (CoRAP) for the REACH Regulation where the PBT and vPvB properties are being considered further.

4.3.3 Benzophenone-1 (BP-1) (CAS No. 131-56-6)

A summary of the environmental fate and effects data for benzophenone-1 is presented in Table 26.

TABLE 26
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BENZOPHENONE-1

Property	Description		Reference
Benzophenone-1 (CAS No. 131-56-6)			
Physico-chemical data	Melting point	144°C	ECHA, 2014A
	Boiling point	375°C (estimated using the MPBPVP v1.43 program)	ECHA, 2014A
	Vapour pressure	3.0×10^{-4} Pa at 25°C (estimated using the MPBPBPv1.43 program)	ECHA, 2014A
	Log Kow	2.96 (estimated using the KOWIN v1.68 program)	ECHA, 2014A
	Water solubility	236 mg/L at 25°C (estimated using the WSKOWv1.43 program)	ECHA, 2014A
Potential for degradation	Predicted to be inherently biodegradable using the BIOWIN v4.10 program.		ECHA, 2014A
Bioaccumulation potential	No information.		
Ecotoxicity	96h-LC_{50} = 3.7 mg/L for fish (*Oryzias latipes*). 48h-EC_{50} = 7.86 mg/L for invertebrates (*Daphnia magna).* No experimental data are available on toxicity to algae and the long-term toxicity to fish and invertebrates using standard test systems but estimates obtained using ECOSAR v1.11 suggest a 30d-Chv of 1.45 mg/L for fish [2], a 21d-Chv of 5.7 mg/L for *Daphnia magna*, and a 96h-EC_{50} of 2.1 mg/L and a 96h-Chv of 0.33 mg/L for algae.		ECHA, 2014A
Environmental Classification	No harmonised classification Notifications: Not classified (>1,000 notifications) Aquatic Chronic 3: H412 (20 notifications) Aquatic Chronic 2: H411 (7 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (3 notifications) Aquatic Acute 1: H400 (2 notifications)		ECHA, 2014A

Environmental fate and persistence

Benzophenone-1 has an estimated water solubility of 235.6 mg/L at 25°C (obtained using the WSKOWv1.43 program; ECHA, 2014A), an estimated log Kow of 2.96 (obtained using the KOWIN v1.68 program; ECHA, 2014A) and an estimated vapour pressure of 3.0×10^{-4} Pa at 25°C (obtained

using the MPBPVPv1.43 program; ECHA, 2014A), suggesting that the substance will bind only relatively weakly to sediment and soil and would be expected to be subject to leaching from soil.

The substance is predicted to be inherently biodegradable (predictions obtained using BIOWIN v4.10; ECHA, 2014A).

Bioaccumulation potential
No experimental data appear to be available on the potential for bioaccumulation. The log Kow of the substance is 2.96, suggesting a relatively low potential for bioaccumulation.

Ecotoxicity
Acute toxicity data are available for fish and aquatic invertebrates. The 96h-LC_{50} for fish is 3.7 mg/L and the 48h-EC_{50} for *Daphnia magna* is 7.86 mg/L (ECHA, 2014A). Estimates of the toxicity to algae obtained using the ECOSAR v1.11 program suggest a 96h-EC_{50} of 2.1 mg/L (ECHA, 2014A).

No experimental data are available for the standard long-term toxicity of the substance to aquatic organisms. Estimates obtained using the ECOSAR v1.11 program suggest the long-term Chv for the substance is around 1.45 mg/L for fish, 5.7 mg/L for *Daphnia magna* and 0.33 mg/L for algae (ECHA, 2014A).

Evaluation
The available evidence suggests that the substance does not meet the REACH Annex XIII criteria for a PBT or vPvB substance based on the low bioaccumulation potential and the long-term NOEC for aquatic organisms being >>0.01 mg/L. A similar conclusion was given in the REACH Registration dossier for this substance.

4.3.4 4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)

A summary of the environmental fate and effects data for 4-Methylbenzylidene camphor (4-MBC) is presented in Table 27.

TABLE 27
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR 3-(4'-METHYLBENZYLIDENE)-DI-CAMPHOR (4-MBC)

Property	Description		Reference
4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)			
Physico-chemical data	Melting point	121°C (estimate obtained using EPWINv3.12)	Environment Agency, 2008
	Boiling point	349°C(estimate obtained using EPWIN v3.12)	Environment Agency, 2008
	Vapour pressure	0.0021 Pa at 25°C (estimate obtained using EPWIN v3.12)	Environment Agency, 2008
	Log Kow	5.92 (estimate obtained using EPIWIN v3.12)	Environment Agency, 2008
	Water solubility	0.2 mg/L at 25°C (estimate obtained using EPIWIN v3.12)	Environment Agency, 2008
Potential for degradation	Predicted to be not readily biodegradable (prediction obtained using EPIWIN v3.12)		Environment Agency, 2008
Bioaccumulation potential	BCF for fish estimated to be 7,224 L/kg (estimate obtained using EPIWIN v3.12)		Environment Agency, 2008

Property	Description	Reference
4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)		
Ecotoxicity	No experimental data have been located for the substance from the REACH Registration dossier. The following estimates are available (all obtained using EPIWIN v3.12): 96h-LC_{50} = 0.51 mg/L and 30d-Chv = 0.008 mg/L for fish. 48h-EC_{50} = 0.11 mg/L and 21d-Chv = 0.047 mg/L for *Daphnia magna*. 96h-EC_{50} = 0.048 mg/L and 96h-Chv = 0.017 mg/L for algae.	Environment Agency, 2008
Environmental classification	No harmonised classification Notifications: Not classified (28 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (201 notifications) Aquatic Chronic 1: H410 (41 notifications)	ECHA, 2014B

Environmental fate and persistence
No experimental data are readily available from the REACH registration dossier for this substance. The water solubility is estimated to be 0.2 mg/L at 25°C, the vapour pressure is estimated to be 0.0021 Pa at 25°C and the log Kow is estimated to be 5.92 (all estimates reported in Environment Agency (2008) and obtained using EPIWN v3.12 program). These data suggest that the substance will adsorb strongly to sediment and soil in the environment.

The substance was predicted to be not readily biodegradable in Environment Agency (2008) based on estimates for biodegradation potential obtained using EPIWIN v3.12.

Bioaccumulation potential
No experimental data are readily available. The substance has a log Kow of 5.92 and the BCF in fish is estimated to be 7,224 L/kg using the EPIWIN v3.12 program (Environment Agency, 2008).

Ecotoxicity
No experimental data from standard ecotoxicity tests are readily available. Estimates obtained using the EPIWIN v3.12 program and reported in Environment Agency (2008) suggest that the lowest acute L(E)C_{50} is 0.048 mg/L over 96 hours for algae and the lowest long-term Chv is 0.008 mg/L for fish.

Evaluation
Based on the available predicted data, the substance potentially meets the REACH Annex XIII screening criteria for both a PBT substance and a vPvB substance as the substance is predicted to be not readily biodegradable, has a predicted log Kow of 5.92 and a predicted long-term NOEC <0.01 mg/L.

No publicly available registration dossier is available for the substance under the REACH Regulation.

4.3.5 2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)

A summary of the environmental fate and effects data for 2-ethylhexyl-4-(dimethylamino)benzoate (OD PABA) is presented in Table 28.

TABLE 28
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR 2-ETHYLEHEXYL-4-(DIMETHYLAMINO)BENZOATE (OD-PABA)

Property	Description		Reference
2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)			
Physico-chemical data	Melting point	97°C (estimate obtained using EPWINv3.12)	Environment Agency, 2008
	Boiling point	345°C (estimate obtained using EPWINv3.12)	Environment Agency, 2008
	Vapour pressure	0.0047 Pa at 25°C (estimate obtained using EPWINv3.12)	Environment Agency, 2008
	Log Kow	5.77 (estimate obtained using EPWINv3.12)	Environment Agency, 2008
	Water solubility	0.2 mg/L at 25°C (estimate obtained using EPWINv3.12)	Environment Agency, 2008
Potential for degradation	Predicted to be not readily biodegradable (prediction obtained using EPIWIN v3.12)		Environment Agency, 2008
Bioaccumulation potential	BCF for fish estimated to be 5,486 L/kg (estimate obtained using EPWIN v3.12)		Environment Agency, 2008
Ecotoxicity	No experimental data have been located for the substance using standard test systems. The following estimates are available (all obtained using EPIWIN v3.12): 96h-LC_{50} = 0.40 mg/L and 30d-Chv [2] = 0.012 mg/L for fish. 48h-EC_{50} = 0.082 mg/L 96h-EC_{50} = 0.037 mg/L and 96h-Chv = 0.031 mg/L for algae.		Environment Agency, 2008
Environmental Classification	No harmonised classification Notifications: Not classified (412 notifications)		ECHA, 2014B

Environmental fate and persistence

No experimental data are available for OD-PABA. Estimates for the physico-chemical properties of the substance give a water solubility of 0.2 mg/L at 25°C, a vapour pressure of 0.0047 Pa at 25°C and a log Kow of 5.77 (all estimates obtained using the EPIWIN v3.12 program; Environment Agency, 2008). The substance is therefore likely to adsorb strongly to sediment and soil in the environment.

Predictions for the biodegradability of the substance suggest that the substance is not readily biodegradable (predictions carried out using the EPIWIN v3.12 program; Environment Agency, 2008).

Bioaccumulation potential
No experimental data are available on the bioaccumulation potential of OD-PABA. The log Kow is estimated to be 5.77 and the BCF in fish is estimated to be 5,486 L/kg (estimates carried out using the EPIWIN v3.12 program; Environment Agency, 2008).

Ecotoxicity
No experimental data from standard ecotoxicity tests are readily available. Estimates obtained using the EPIWIN v3.12 program and reported in Environment Agency (2008) suggest that the lowest acute L(E)C_{50} is 0.037 mg/L over 96 hours for algae and the lowest long-term Chv is 0.012 mg/L for fish.

Evaluation
Based on the available predicted data, the substance potentially meets the REACH Annex XIII screening criteria for a vPvB substance as the substance is predicted to be not readily biodegradable and has a predicted log Kow of 5.77 and predicted fish BCF of 5,486 L/kg. There are no long-term toxicity data available for aquatic organisms but the estimated long-term chronic value for the substance in fish is 0.012 mg/L which is close to the 0.01 mg/L cut-off for a toxic substance.

No publicly available registration dossier is available for the substance under the REACH Regulation.

4.3.6 Titanium dioxide (CAS No. 13463-67-7)
A summary of the environmental fate and effects data for titanium dioxide is presented in Table 29.

TABLE 29
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR TITANIUM DIOXIDE

Property	Description		Reference
Titanium dioxide (CAS No. 13463-67-7)			
Physico-chemical data	Melting point	1843°C	ECHA, 2014A
	Boiling point	ca. 3,000°C	ECHA, 2014A
	Vapour pressure	Vapour pressure is very low (high melting point solid).	ECHA, 2014A
	Log Kow	log Kow is not applicable for an inorganic substance.	ECHA, 2014A Environment Agency, 2008 OECD, 2013
	Water solubility	<0.001 mg/L at 20°C	ECHA, 2014A
Potential for degradation	The substance is an inert inorganic solid and is not susceptible to significant degradation in the environment.		ECHA, 2014A Environment Agency, 2008 OECD, 2013
Bioaccumulation potential	BCF in fish muscle = 272 L/kg. BSAF for Ti ranged between 0.0002 and 0.0008 kg/kg for plants.		ECHA, 2014A
Ecotoxicity	The weight of evidence is that the substance is of low		ECHA, 2014A

Property	Description	Reference
Titanium dioxide (CAS No. 13463-67-7)		
	toxicity to aquatic organisms. 96h-LL_{50} >100 mg/L for fish (*Oryzias latipes*). 48h-EL_{50} >100 mg/L for invertebrates (*Daphnia magna*). 72h-EL_{50} >100 mg/L for algae. [$L(E)L_{50}$ = loading rate that causes 50% effect/lethality]	OECD, 2013
Environmental Classification	No harmonised classification Notifications: Not classified (>1,000 notifications) Aquatic Chronic 4: H413 (25 notifications) Aquatic Chronic 3: H412 (7 notifications)	ECHA, 2014B

Environmental fate and persistence
Titanium dioxide has a very low water solubility (<0.001 mg/L at 20°C; ECHA, 2014A) and, as the substance is an inorganic solid with a high melting point, it is essentially non-volatile (ECHA, 2014A). The log Kow is not a relevant physico-chemical property for an inorganic substance.

The substance is an inert inorganic solid and is not susceptible to significant degradation in the environment (ECHA, 2014A, Environment Agency, 2008 and OECD, 2013).

Bioaccumulation potential
The BCF for titanium dioxide has been determined to be 272 L/kg in fish muscle (ECHA, 2014A). The test was carried out with *Oncorhynchus mykiss* using a nano-form of titanium dioxide dispersed in water (concentrations of 0.1, 0.5 and 1.0 mg/L with a 14-day exposure period). Biota-soil accumulation factors (BSAFs) between 0.0002 and 0.0008 kg/kg have been measured for titanium in plants (ECHA, 2014A).

Ecotoxicity
Titanium dioxide has been shown to have a low toxicity to aquatic organisms in standard acute toxicity tests with no toxicity being seen at loading rates of 100 mg/L (OECD, 2013). This suggests that the substance is not acutely toxic to aquatic organisms at concentrations up to its solubility limit.

Evaluation
The REACH Annex XIII screening criteria are not appropriate for an inorganic substance.
The substance is currently on the CoRAP[29] for the REACH Regulation where the vPvB properties are being considered further.

4.3.7 Butyl methoxydibenzoylmethane (BMDBM) (CAS No. 70356-09-1)

A summary of the environmental fate and effects data for butyl methoxy-dibenzoylmethane is presented in Table 30.

TABLE 30
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BUTYL METHOXY-DIBENZOYLMETHANE (BMDBM)

[29] Commission Rolling Action Plan - http://echa.europa.eu/regulations/reach/evaluation/substance-evaluation/community-rolling-action-plan

Property	Description		Reference
Butyl methoxy-dibenzoylmethane (CAS No. 70356-09-1)			
Physico-chemical data	Melting point	81-86°C	ECHA, 2014A
	Boiling point	>400°C	ECHA, 2014A
	Vapour pressure	$<1\times10^{-5}$ Pa at 25°C	ECHA, 2014A
	Log Kow	6.1	ECHA, 2014A
	Water solubility	0.027 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable and not inherently biodegradable. Not degradable in an anaerobic degradation screening test.		ECHA, 2014A Environment Agency, 2008
Bioaccumulation potential	Biomagnification factor (BMF) for fish = 0.122 determined in a dietary accumulation test with *Oncorhynchus mykiss*. The elimination half-life was 3.8 days.		ECHA, 2014A
Ecotoxicity	96h-LL^{30}_{50} >100 mg/L for fish (*Cyprinus carpio*). 48h-EL_{50} >100 mg/L for invertebrates (*Daphnia magna*). 72h-EL_{50} >100 mg/L and 72h-NOEC ≥.100 mg/L for algae (*Pseudokirchneriella subcapitata*). No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems. Estimates obtained using the EPIWIN v3.12 program suggest a 21d-Chv of 0.030 mg/L for *Daphnia magna*.		ECHA, 2014A Environment Agency, 2008
Environmental Classification	No harmonised classification Notifications: Not classified (5 notifications) Aquatic Chronic 4: H413 (>1,000 notifications) Aquatic Chronic 2: H411 (29 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (23 notifications) Aquatic Chronic 3: H412 (19 notifications)		ECHA, 2014B

Environmental fate and persistence

Butyl methoxy-dibenzoylmethane has a water solubility of 0.027 mg/L at 20°C, a very low vapour pressure ($<1\times10^{-5}$ Pa at 25°C) and a log Kow of 6.1 (ECHA, 2014A). The relatively high log Kow

[30] L(E)L50 = loading rate that causes 50% effect/lethality

value suggests that the substance will bind strongly to sediment and soil and would be expected to be relatively immobile in such media.

The substance has been shown to be not readily biodegradable (Environment Agency, 2008; details of the test method used are not known) or inherently biodegradable (OECD 302 test guideline modified MITI test II; ECHA, 2014A). In addition, no significant degradation was seen in an anaerobic degradation screening test (ISO 11734:1995 test method; ECHA, 2014A). These results suggest that the substance will be persistent in the environment.

Bioaccumulation potential

No experimental information is available on the BCF for the substance in fish. The log Kow of 6.1 suggests that the substance may have a high potential for bioaccumulation; however, a biomagnification factor (BMF[31]) of 0.122 has been determined in a dietary accumulation test with fish, suggesting that the substance does not biomagnify (ECHA, 2014A). The test was carried out with *Oncorynchus mykiss* using a draft version of the OECD 305 test guideline. The elimination half-life from fish was reported to be 3.8 days.

Ecotoxicity

In acute toxicity tests, no significant adverse effects have been demonstrated with the substance in fish, aquatic invertebrates and algae at loading rates of 100 mg/L (ECHA, 2014A), showing that the substance is not acutely toxic at concentrations up to its water solubility.

No experimental data are available on the long-term toxicity of the substance to fish and aquatic invertebrates using standard test systems, but estimates reported by Environment Agency (2008) obtained using the EPIWIN v3.12 program suggest that the long-term Chv for *Daphnia magna* will be around 0.03 mg/L.

Evaluation

Based on the available ecotoxicity data, the substance does not meet the Annex XIII screening criteria for T. The substance does meet the Annex XIII screening criteria for both P and vP but the situation with regard to the bioaccumulation potential is less clear. Based on the log Kow of 6.1, the Annex XIII screening criteria for both B and vB would be met but the available data from a dietary accumulation study suggests that the substance does not biomagnify. The actual BCF for this substance is not known and so it is currently not possible to conclude whether or not the substance meets the B or vB criteria. The REACH Registration dossier concluded that although the substance meets the screening criteria of P and vP, it did not meet the criteria for B, vB or T.

4.3.8 Ethylhexyl salicylate (CAS No. 118-60-5)

A summary of the environmental fate and effects data for ethylhexyl salicylate is presented in Table 31.

TABLE 31
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR ETHYLHEXYL SALICYLATE

Property	Description		Reference
Ethylhexyl salicylate (CAS No. 118-60-5)			
Physico-chemical data	Melting point	<-20°C	ECHA, 2014A
	Boiling point	>300°C	ECHA, 2014A
	Vapour	0.018 Pa at 20°C	ECHA, 2014A

[31] The biomagnification factor from a dietary accumulation test represents the steady-state ratio of the concentration in the exposed organisms to that in the diet.

Property	Description		Reference
Ethylhexyl salicylate (CAS No. 118-60-5)			
	pressure		
	Log Kow	>6	ECHA, 2014A
	Water solubility	<0.5 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Readily biodegradable		ECHA, 2014A
Bioaccumulation potential	BCF for fish estimated to be 124 L/kg using the BCFBAF v3.01 progam		ECHA, 2014A
Ecotoxicity	96h-LC_{50} >82 mg/L for fish (*Danio rerio*). 48h-EC_{50} = 10 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >0.011 mg/L and 72h-NOEC ≥.0.011 mg/L for algae (*Pseudokirchneriella subcapitata*). No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems. Estimates obtained using the EPIWIN v3.12 program suggest a 30d-Chv of 0.008-0.018 mg/L for fish and 21d-Chv of 0.014 mg/L for *Daphnia magna*.		ECHA, 2014A Environment Agency, 2008
Environmental classification	No harmonised classification Notifications: Not classified (893 notifications)		ECHA, 2014B

Environmental fate and persistence

The water solubility of ethylhexyl salicylate is <0.5 mg/L at 20°C and the log Kow is >6 (ECHA, 2104A). The vapour pressure has been determined as 0.018 Pa at 20°C. Based on these properties the substance is expected to be relatively immobile in sediment and soil, although volatilisation to the atmosphere from water would be expected to occur to some extent.

The substance has been shown to be readily biodegradable in a closed bottle test (EU Method C.4-E; ECHA, 2014A) and so should not persist in the environment.

Bioaccumulation potential

The BCF for ethylhexyl salicylate has been estimated to be 124 L/kg using the BCFBAF v3.01 program (ECHA, 2014A).

Ecotoxicity

No effects have been seen in acute toxicity tests with aquatic organisms at the highest concentrations that could be feasibly tested (ECHA, 2014A). No long-term toxicity data are available using standard test systems, but estimates carried out using the EPIWIN v3.12 program suggest that the long-term Chv could be in the range 0.008-0.018 mg/L for fish and around 0.014 mg/L for *Daphnia magna* (Environment Agency, 2008). The water solubility of this substance is given as an upper limit value (<0.5 mg/L at 20°C) and so the actual water solubility is not known.

Therefore it is not clear whether or not the substance is sufficiently water soluble to allow these chronic values to be reached in practice.

Evaluation
Based on the available evidence the substance is unlikely to meet the REACH Annex XIII criteria for PBT or vPvB as the substance is readily biodegradable. No experimental data are available on the bioaccumulation potential but, although the substance has a relatively high log Kow (>6), the estimated BCF for fish is 124 L/kg. Therefore, the substance would potentially meet the REACH Annex XIII screening criteria for a bioaccumulative and very bioaccumulative substance based on the log Kow but would not meet the criteria based on the predicted BCF. Therefore, the assessment of the bioaccumulation potential depends on the reliability of the predicted BCF for this substance.

The available data suggests that the substance is also not toxic at the limit of water solubility but no experimental data are available on the long-term toxicity to fish and aquatic invertebrates. Predictions of the long-term toxicity to fish suggest that the NOEC for fish could be <0.01 mg/L but, owing to the lack of information on the actual water solubility of the substance, it is not clear if this concentration could be reached in practice. The REACH registration concluded that the substance did not meet the criteria for PBT and vPvB.

4.3.9 Ethylhexyl triazone (CAS No. 88122-99-0)

A summary of the environmental fate and effects data for ethylhexyltriazone is presented in Table 32.

TABLE 32
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR ETHYLHEXYLTRIAZONE

Property	Description		Reference
Ethylhexyl triazone (CAS No. 88122-99-0)			
Physico-chemical data	Melting point	114-130°C	ECHA, 2014A
	Boiling point	>400°C (predicted value using the adapted Stein and Brown method)	ECHA, 2014A
	Vapour pressure	Vapour pressure ≤6×10^{-6} Pa at 20°C	ECHA, 2014A
	Log Kow	>7	ECHA, 2014A
	Water solubility	0.005 mg/L at 25°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable.		ECHA, 2014A
Bioaccumulation potential	BCF in fish = 80 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} >1,000 mg/L for fish (*Danio rerio*). 48h-EC_{50} >500 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >80 mg/L for algae (*Desmodesmus subspicatus*). [2] No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems and it is not possible to carry out reliable		ECHA, 2014A * Estimates carried out for this report using EPI Suite

Property	Description	Reference
Ethylhexyl triazone (CAS No. 88122-99-0)		
	estimates for this substance as it is outside of the applicability domain of the available methods*	v4.11
Environmental Classification	Harmonised classification: Aquatic Chronic 4: H413 Notifications: Aquatic Chronic 4: H413 (174 notifications)	ECHA, 2014B

Environmental fate and persistence

Ethylhexyl triazone has a water solubility of 0.005 mg/L at 20°C, a vapour pressure of ≤6×10^{-6} Pa at 20°C and a log Kow value >7 (ECHA, 2014A). This information suggests that the substance will adsorb strongly onto sediment and soil in the environment and will be relatively immobile in such media.

The substance is not readily biodegradable in both the manometric respiratometry test (EU Method C.4-D; ECHA, 2014A) and the modified MITI test (I) (OECD 301C test guideline; ECHA, 2014A) and so is potentially persistent in the environment.

Bioaccumulation potential

Although ethylhexyltriazone has a high log Kow value, the BCF for the substance has been determined to be 80 L/kg in fish (ECHA, 2014A). The test was carried out using *Danio rerio* and followed the OECD 305 test guideline. The exposure period used in the test was a 28 day uptake period followed by a 16 day depuration period and the substance tested was ^{14}C-labelled. No information is given on the concentrations tested and so it is not known if the substance was tested at concentrations below its water solubility limit. The results of this test indicate a low potential for bioaccumulation in aquatic organisms but there are currently some uncertainties about the exposure concentrations used.

Ecotoxicity

The available ecotoxicity data show that the substance is not toxic to fish, aquatic invertebrates and algae at concentrations well in excess of the water solubility of the substance (ECHA, 2014A). No long-term toxicity data are available using standard test systems and it is not possible to estimate such toxicity reliably using simple estimation methods.

Evaluation

The available information suggests that, although the substance potentially meets the Annex XIII screening criteria for P and vP based on the lack of ready biodegradability the substance is unlikely to meet the Annex XIII criteria for either B or vB based on the experimental BCF value. However, it should be noted that the exposure concentrations used in the BCF study are not currently clear, introducing some uncertainty into the result. The available ecotoxicity data shows that the substance is not acutely toxic at concentrations up to the water solubility limit but the potential for long-term toxicity is currently unclear. Overall it is not clear if the substance does or does not meet the screening criteria for PBT or vPvB. The REACH Registration dossier concluded that the substance did not meet the criteria for either PBT or vPvB.

4.3.10 Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)

A summary of the environmental fate and effects data for bis-ethylhexyloxyphenol methoxyphenyl triazine is presented in Table 33.

TABLE 33
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BIS-ETHYLHEXYLOXYPHENOL METHOXYPHENYL TRIAZINE

Property	Description		Reference
Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)			
Physico-chemical data	Melting point	80.4°C	ECHA, 2014A
	Boiling point	>400°C	ECHA, 2014A
	Vapour pressure	~6×10^{-20} Pa at 25°C (estimated from the boiling point)	ECHA, 2014A
	Log Kow	>5.7	ECHA, 2014A
	Water solubility	<0.014 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable. Half-life in soil >1,000 days at 20°C.		ECHA, 2014A
Bioaccumulation potential	BCF in fish = 19 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} >0.81 mg/L for fish (*Danio rerio*). 48h-EC_{50} >0.114 mg/L and 21d-NOEC ≥0.7 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >0.017 mg/L and 72h-NOEC ≥0.017 mg/L for algae (*Desmodesmus subspicatus*). No experimental data are available on the long-term toxicity to fish using standard test systems and it is not possible to carry out reliable QSAR estimates for this substance as it is outside of the applicability domain of the available methods. *		ECHA, 2014A *Estimates carried out for this report using EPI Suite v4.11.
Environmental classification	No harmonised classification Notifications: Not classified (29 notifications) Aquatic Chronic 4: H413 (1 notification)		ECHA, 2014B

Environmental fate and persistence

Bis-ethylhexyloxyphenol methoxyphenyl triazine has a low water solubility (<0.014 mg/L at 20°C), low vapour pressure (~6×10^{-20} Pa at 20°C; value estimated from the boiling point) and a log Kow > 5.7 (ECHA, 2014A). These data suggest the substance will be relatively immobile in the environment, adsorbing strongly onto sediments and soil.

The substance is not readily biodegradable in the manometric respirometry test (OECD 301F test guideline; ECHA, 2014A) and the half-life in soil has been determined to be >100 days at 20°C in an simulation test carried out according to the OECD 307 test guideline (ECHA, 2014A). The substance is therefore likely to be persistent in the environment.

Bioaccumulation potential
Although the substance has a log Kow value >5.7 the potential for bioaccumulation in aquatic organism is low based on a measured BCF value of 19 obtained in fish (ECHA, 2014A). The test was carried out using *Cyprinus carpio* using the MITI test guideline. The substance, however, appears to have been tested above its water solubility using a dispersant, which means that the results of the test are uncertain.

Ecotoxicity
The available ecotoxicity data show that the substance is not toxic to fish, aquatic invertebrates and algae at concentrations well in excess of the water solubility of the substance (ECHA, 2014A). The available experimental data also show that the long-term NOEC for both aquatic invertebrates and algae is also above the water solubility of the substance (ECHA, 2014A). No long-term toxicity data are available for fish using standard test systems and it is not possible to estimate such data using simple QSAR methods.

Evaluation
The available information suggests that the substance likely meets the Annex XIII criteria for P and vP based on the substance being not readily biodegradable and the half-life in soil being > 100 days. It is not currently clear whether or not the substance meets the Annex XIII criteria for either B or vB owing to uncertainties surrounding the BCF value. The available ecotoxicity data shows that the substance is not acutely toxic or toxic over longer-term exposures at concentrations up to the water solubility limit, but the potential for long-term toxicity to fish is currently unclear. Overall it is not clear whether or not the substance meets the criteria for PBT or vPvB. The REACH Registration dossier concluded that the substance did not meet the criteria for either PBT or vPvB.

4.3.11 Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)
A summary of the environmental fate and effects data for diethylamino hydroxybenzoyl hexyl benzoate is presented in Table 34.

TABLE 34
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR DIETHYLAMINO HYDROXYBENZOYL HEXYL BENZOATE

Property	Description		Reference
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)			
Physico-chemical data	Melting point	54°C	ECHA, 2014A
	Boiling point	>314°C (decomposes)	ECHA, 2014A
	Vapour pressure	2.9×10^{-6} Pa at 20°C	ECHA, 2014A
	Log Kow	6.2	ECHA, 2014A
	Water solubility	0.016 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable.		ECHA, 2014A
Bioaccumulation potential	BCF in fish = 167 L/kg. Elimination DT_{90} ~ 4 days.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} > 100 mg/L for fish (*Danio rerio*) and 34d-NOEC ≥ 0.0088 mg/L for fish (*Pimephales*		ECHA, 2014A

Property	Description	Reference
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)		
	promelas). 48h-EC_{50} >100 mg/L and 21d-NOEC ≥0.014 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >100 mg/L and 72h-NOEC ≥0100 mg/L for algae (*Desmodesmus subspicatus*). Toxicity data are also available for soil organisms: 14d-LC_{50} >1,000 mg/kg dry weight for *Eisenia fetida*. 25d-EC_{50} = 80.4 mg/kg dry weight for *Brasssica napus*. 25d-EC_{50} >1,000 mg/kg dry weight for *Avena sativa*. 25d-EC_{50} >500 mg/kg dry weight for *Vicia sativa*. 28d-EC_{10} >1,000 mg/kg dry weight for soil microorganisms.	
Environmental classification	Harmonised classification: Aquatic Chronic 4: H413 Notifications: Not classified (1 notification) Aquatic Chronic 4: H413 (176 notifications)	ECHA, 2014B

Environmental fate and persistence
Diethylamino hydroxybenzoyl hexyl benzoate has a water solubility of 0.016 mg/L at 20°C, a vapour pressure of 2.9×10^{-6} Pa at 20°C and a log Kow of 6.2 (ECHA, 2014A). The substance is likely to adsorb strongly onto sediment and soil and be relatively immobile in such media.

The substance is not readily biodegradable in the manometric respirometry test (OECD 301F test guideline; ECHA, 2014A) and so is potentially persistent.

Bioaccumulation potential
Although the substance has a relatively high log Kow of 6.2, the BCF in fish has been determined to be 167 L/kg. The elimination half-life in fish was around 4 days (ECHA, 2014A). The test was carried out using the OECD 305 test guideline with *Danio rerio*. The test consisted of a 28 day uptake period followed by a 16-21 days depuration period and the concentrations of the substance tested were 0.096 and 0.97 µg/L, which are below the water solubility of the substance. The experimental data in fish suggests that the substance has a low potential for bioaccumulation in aquatic organisms.

Ecotoxicity
The substance has been shown to be essentially nontoxic to fish, aquatic invertebrates and algae over both short-term and long-term exposure to concentrations up to the water solubility limit (or the highest concentrations that could feasibly be tested) in standard test systems (ECHA, 2014A).

Toxicity data are available for soil organisms, including plants, earthworms and soil microorganisms. The most sensitive species tested was the plant *Brassica napus* and the 25d-EC_{50} was determined to be 80.4 mg/kg dry weight for this species (ECHA, 2014A).

Evaluation
The available information shows that the substance is unlikely to meet the REACH Annex XIII criteria for either PBT or vPvB. Although the substance is potentially persistent (or very persistent), the BCF in fish is relatively low (167 L/kg) and the substance is essentially not toxic to aquatic organisms at concentrations up to its water solubility limit.

4.3.12 Diethylhexyl butamido triazone (CAS No. 154702-15-5)

A summary of the environmental fate and effects data for diethylhexy butamido triazone is presented in Table 35.

TABLE 35
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR DIETHYLHEXYL BUTAMIDO TRIAZONE

Property	Description		Reference
Diethylhexyl butamido triazone (CAS No. 154702-15-5)			
Physico-chemical data	Melting point	88.3-91.4°C	ECHA, 2014A
	Boiling point	>400°C	ECHA, 2014A
	Vapour pressure	$<1.9\times10^{-4}$ Pa at 25°C	ECHA, 2014A
	Log Kow	4.12	ECHA, 2014A
	Water solubility	$<7.5\times10^{-4}$ mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable. Half-life for hydrolysis is predicted to be >1 year.		ECHA, 2014A
Bioaccumulation potential	No information.		
Ecotoxicity	96h-LC_{50} >2.48 mg/L for fish (*Danio rerio*). 48h-EC_{50} >1.88 mg/L for invertebrates (*Daphnia magna*). 68h-EC_{50} >2.7 mg/L and 68h-NOEC ≥2.7 mg/L for algae (*Pseudokirchneriella subcapitata*). No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems but estimates carried out using the ECOSAR v1.11 program suggest a 30d-Chv of 0.859 mg/L for fish and 21d-Chv of 0.95 mg/L for *Daphnia magna*.		ECHA, 2014A
Environmental classification	No harmonised classification Notifications: Aquatic Chronic 4: H413 (6 notifications)		ECHA, 2014B

Environmental fate and persistence
The substance has a low water solubility ($<7.5\times10^{-4}$ mg/L at 20°C) and vapour pressure ($<1.9\times10^{-4}$ Pa at 25°C) and a log Kow of 4.12 (ECHA, 2014A). These data suggest that the substance will adsorb to sediment and soil to some extent but movement by leaching and volatilisation, although possible, is likely to be limited by the low water solubility and vapour pressure.

The substance is not readily biodegradable in the CO_2 evolution test (OECD 301B test guideline; ECHA, 2014A). The substance is predicted to by hydrolytically stable in the environment (hydrolysis half-life > 1 year) based on comparison with related substances (no further details are available; ECHA, 2014A). The substance is therefore potentially persistent.

Bioaccumulation potential

No experimental information is available on the potential for bioaccumulation. The log Kow of the substance is 4.12 and although this suggests that the substance may have some potential for bioaccumulation, the value is below the screening criterion used to identify substances that are potentially bioaccumulative in relation to the REACH Annex XIII criteria.

Ecotoxicity

The substance is not acutely toxic to fish, aquatic invertebrates and algae at concentrations up to the water solubility limit in the test media (ECHA, 2014A).

No experimental long-term toxicity data are available for fish or aquatic invertebrates using standard test systems but the estimated Chv for fish (0.859 mg/L) and *Daphnia magna* (0.95 mg/L) obtained using the ECOSAR v1.11 program (ECHA, 2014A) are both in excess of the water solubility of the substance, suggesting that the substance is not toxic over long-term exposure.

Evaluation

The substance is unlikely to meet the REACH Annex XIII criteria for PBT or vPvB. Although the substance is potentially persistent or very persistent, the substance has a log Kow below the screening criteria for B and vB and the substance is (or is predicted to be) nontoxic to aquatic organisms up to its water solubility limit. The REACH Registration dossier also concluded that the substance was not PBT or vPvB.

4.3.13 Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3)

A summary of the environmental fate and effects data for ethylhexy methoxy cinnamate is presented in Table 36.

TABLE 36
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR ETHYLHEXYL METHOXY CINNAMATE **(OMC)**

Property	Description		Reference
Ethylhexyl methoxycinnamate (CAS No. 5466-77-3)			
Physico-chemical data	Melting point	-68.3°C	ECHA, 2014A
	Boiling point	383°C	ECHA, 2014A
	Vapour pressure	30 Pa at 154°C	ECHA, 2014A
	Log Kow	>6	ECHA, 2014A
	Water solubility	0.22-0.75 mg/L at 21°C	ECHA, 2014A
Potential for degradation	Readily biodegradable and also degradable under anaerobic conditions. Half-life for hydrolysis >1 year at 20°C and pH 4, 7 and 9. Half-life for direct photolysis in water estimated to be around 5-9 days.		ECHA, 2014A

Property	Description	Reference
Ethylhexyl methoxycinnamate (CAS No. 5466-77-3)		
Bioaccumulation potential	BCF in fish 433 L/kg. Depuration half-life 1.5-1.7 days.	ECHA, 2014A
Ecotoxicity	96h-LC_{50} > 100 mg/L for fish (*Cyprinus carpio*) 48h-EC_{50} >0.0271 mg/L for invertebrates (*Daphnia magna*) 72h-EC_{50} >100 mg/L and 72h-NOEC = 32 mg/L for algae (*Pseudokirchneriella subcapitata*) No experimental data are available in the registration dossier on the long-term toxicity to fish and invertebrates using standard test systems but estimates obtained using the EPIWIN v3.12 program suggest a 32d-Chv of 0.003 mg/L for fish.	ECHA, 2014A Environment Agency, 2008
Environmental classification	No harmonised classification Notifications: Not classified (>1,000 notifications) Aquatic Chronic 4: H413 (37 notifications)	ECHA, 2014B`

Environmental fate and persistence
Ethylhexyl methoxycinnamate has a water solubility of 0.22-0.75 mg/L at 21°C, a vapour pressure of 30 Pa at 154°C and log Kow >6 (ECHA, 2014A). The substance is likely to adsorb strongly to sediment and soil, but the water solubility suggests that the substance may have some potential for leaching.

The substance is readily biodegradable in the manometric respirometry test (OECD 301F test guideline; ECHA, 2014A) and also degradable under anaerobic conditions (ISO 11734: 1995 test method; ECHA, 2014A). The substance is hydrolytically stable (hydrolysis half-life >1 year at 20°C determined using the OECD 111 test guideline; ECHA, 2014A) but may degrade by direct photolysis in water (half-life estimated to be around 5-9 days using a method based on EPA Guideline Subdivision N 161-2; ECHA, 2014A). Overall the data suggest that the substance is not persistent in the environment.

Bioaccumulation potential
The log Kow of ethylhexyl methoxy cinnamate is >6, suggesting a potential for bioaccumulation. However, the BCF in fish for the substance has been determined to be 433 L/kg and the depuration half-life from fish was around 1.5-1.7 days. The test followed the OECD 305 test guideline with *Oncorhynchus mykiss* and consisted of a 5 day uptake period followed by a 9 day depuration period. The substance was tested at concentrations of 0.084 mg/L and 0.73 mg/L, which are both below the water solubility of the substance, and steady state appears to have been rapidly established. These experimental data therefore suggest a relatively low potential for bioaccumulation in aquatic organisms.

Ecotoxicity
The available short-term ecotoxicity data show that the substance is not acutely toxic at concentrations well above the water solubility of the substance (or at the highest concentration that could feasibly be tested) (ECHA, 2014A).

No experimental data are available on the long-term toxicity to fish and aquatic invertebrates using standard test systems. Estimates carried out at the Environment Agency (2008) using the EPIWIN v3.12 program suggest that the long-term Chv for fish could be around 0.003 mg/L.

Evaluation
The available data suggest that the substance does not meet the REACH Annex XIII screening criteria for either PBT or vPvB. The substance is readily biodegradable, has a fish BCF of 433 L/kg and is rapidly depurated from fish, and so does not appear to meet the screening criteria for P, vP, B or vB. Although the available experimental data suggest that the substance is not toxic to aquatic organisms at concentrations up to its water solubility, estimates suggest that the long-term NOEC for fish could be below 0.01 mg/L; therefore, it is not clear whether or not the T-criterion is met. The REACH Registration concluded that the substance was not PBT or vPvB.

The substance is currently on the CoRAP for the REACH Regulation where the PBT properties are being considered further.

4.3.14 Homosalate (HMS) (CAS No. 118-56-9)

A summary of the environmental fate and effects data for homosalate is presented in Table 37.

TABLE 37
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR HOMOSALATE **(HMS)**

Property	Description		Reference
Homosalate (CAS No. 118-56-9)			
Physico-chemical data	Melting point	<-20°C	ECHA, 2014A
	Boiling point	295.1°C	ECHA, 2014A
	Vapour pressure	0.013 Pa at 20°C	ECHA, 2014A
	Log Kow	>6 (~6.18 and 6.5 for two constituents)	ECHA, 2014A
	Water solubility	0.4 mg/L at 25°C	ECHA, 2014A
Potential for degradation	Inherently biodegradable. Half-life for hydrolysis at 20.3°C is 10.3 days at pH 4, 9.7 days at pH 7 and 4.8 days at pH 9.		ECHA, 2014A
Bioaccumulation potential	BCF for fish predicted to be 224 L/kg using BCFBAF v3.01 or 11,080 L/kg using EPIWIN v3.12.		ECHA, 2014A Environment Agency, 2008
Ecotoxicity	96h-LC_{50} >82 mg/L for fish (*Danio rerio*). 48h-EC_{50} >100 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >0.0089 mg/L and 72h-NOEC ≥0.0089 mg/L for algae (*Pseudokirchneriella subcapitata*). No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems but estimates obtained using the EPWIN v3.12		ECHA, 2014A Environment Agency, 2008

Property	Description	Reference
Homosalate (CAS No. 118-56-9)		
	program suggest a 30d-Chv of 0.005-0.015 mg/L for fish (dependent on whether the substance is considered to be an ester or a phenol) and 21d-Chv of 0.012 mg/L for *Daphnia magna*.	
Environmental Classification	No harmonised classification Notifications: Not classified (99 notifications)	ECHA, 2014B

Environmental fate and persistence
Homosalate has a water solubility of 0.4 mg/L, a vapour pressure of 0.013 Pa at 20°C and a log Kow of 6.18-6.5 (ECHA, 2014A). This suggests that although the substance is likely to adsorb strongly to sediment and soil, some limited movement by leaching and/or volatilisation is also possible.

The substance is inherently biodegradable in the modified MITI test (II) (OECD 302C test guideline; ECHA, 2014A). The hydrolysis half-life at 20°C has been determined to be around 10 days at pH 4 and 7, and 4.8 days at pH 9 using the OECD 111 test guideline (ECHA, 2014A).

Bioaccumulation potential
The log Kow of the substance (6.18-6.5) suggests a potential for bioaccumulation. No experimental BCF data are available but estimates for the fish BCF give conflicting values of 224 L/kg (using the BCFBAF v3.01 program; ECHA, 2014A) and 11,080 L/kg (using the EPIWIN v3.12 program; Environment Agency, 2008). Therefore the potential for bioaccumulation is unclear.

Ecotoxicity
The available short-term ecotoxicity data show that the substance is not acutely toxic at concentrations well above the water solubility of the substance (or at the highest concentration that could feasibly be tested) (ECHA, 2014A).

No experimental data are available on the long-term toxicity to fish and aquatic invertebrates using standard test systems. Estimates carried out by Environment Agency (2008) using the EPIWIN v3.12 program suggest that the long-term Chv could be around 0.005-0.015 mg/L for fish and 0.012 mg/L for *Daphnia magna*.

Evaluation
The available data suggest that the substance could potentially meet the Annex XIII screening criteria for PBT and/or vPvB. Although the substance is inherently biodegradable and subject to hydrolysis, the actual biodegradation half-life in sediment or soil is not known and, as a result, it is unclear whether the P or vP criteria are met or not. Similarly, there are uncertainties about the bioaccumulation potential and long-term toxicity, which means that it is also unclear whether or not the B, vB or T criteria are met. The REACH Registration dossier concluded that the substance was not PBT or vPvB.

4.3.15 Drometrizol trisiloxane (CAS No. 155633-54-8)

A summary of the environmental fate and effects data for drometrizol trisiloxane is presented in Table 38.

TABLE 38
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR DROMETRIZOL TRISILOXANE

Property	Description		Reference
Drometrizol trisiloxane (CAS No. 155633-54-8)			
Physico-chemical data	Melting point	No data	
	Boiling point	No data	
	Vapour pressure	5.4×10^{-10} Pa at 25°C*	*Estimates carried out for this report using EPI Suite v4.11.
	Log Kow	10.82*	*Estimates carried out for this report using EPI Suite v4.11.
	Water solubility	6.4×10^{-7} mg/L at 25°C*	*Estimates carried out for this report using EPI Suite v4.11.
Potential for degradation	Predicted to be not readily biodegradable*		*Estimates carried out for this report using EPI Suite v4.11.
Bioaccumulation potential	Estimated BCF in fish up to 180 L/kg*		*Estimates carried out for this report using EPI Suite v4.11.
Ecotoxicity	No experimental data on the ecotoxicity of this substance have been located using standard test systems and it is not possible to carry out reliable estimates for this substance as it is outside of the applicability domain of the available methods within EPI Suite V4.11.		
Environmental classification	Not listed		ECHA, 2014B

Environmental fate and persistence

No experimental data are available for drometrizol trisiloxane. Estimates for the physico-chemical properties of the substance obtained using the EPI Suite v4.11 program give a water solubility of 6.4×10^{-7} mg/L at 25°C, a vapour pressure of 5.4×10^{-10} Pa at 25°C and a log Kow of 10.82. The substance is therefore likely to adsorb strongly to sediment and soil and be relatively immobile in the environment.

Predictions for the biodegradability of the substance obtained using the EPI Suite v4.11 program suggest that the substance is not readily biodegradable.

Bioaccumulation potential
No experimental data are available on the bioaccumulation potential. The log Kow is estimated to be 10.82 and the BCF in fish is estimated to be up to 180 L/kg using the EPI Suite v4.11 program. The reliability of this prediction for a substance with such a high log Kow is unclear. The high log Kow value for this substance may mean that the bioavailability of the substance in the environment is limited.

Ecotoxicity
No experimental data on the ecotoxicity of drometrizol trisiloxane using standard test systems are readily available and it is not possible to carry out reliable estimates of the toxicity for this substance as it is outside of the applicability domain of the available simple methods.

Evaluation
Based on the available estimated data, the substance does not appear to meet the REACH Annex XIII screening criteria for either a PBT or vPvB substance as, although the substance is predicted to be not readily biodegradable, the fish BCF predicted is relatively low. The reliability of these predictions for this substance is unclear. No information is currently available on the ecotoxicity of the substance.

No publicly available registration dossier is available for the substance under the REACH Regulation.

4.3.16 Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)

A summary of the environmental fate and effects data for terephthalylidene dicamphor sulfonic acid is presented in Table 39.

TABLE 39
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR TEREPHTHALYLIDENE DICAMPHOR SULFONIC ACID

Property	Description		Reference
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)			
Physico-chemical data	Melting point	No data	
	Boiling point	No data	
	Vapour pressure	8.4×10^{-21} Pa at 25°C	*Estimates carried out for this report using EPI Suite v4.11.
	Log Kow	3.83	*Estimates carried out for this report using EPI Suite v4.11.
	Water solubility	0.15 mg/L at 25°C	*Estimates carried out for this report using EPI Suite v4.11.
Potential for degradation	Predicted to be not readily biodegradable		*Estimates carried out for this report using EPI Suite v4.11.

Property	Description	Reference
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)		
Bioaccumulation potential	Predicted BCF in fish up to 350 L/kg.	*Estimates carried out for this report using EPI Suite v4.11.
Ecotoxicity	No experimental data on the ecotoxicity of this substance using standard test systems have been located. The following are values estimated using the EPI Suite v4.11 program*: 96h-LC_{50}= 230 mg/L and 30d-Chv = 32 mg/ for fish. 48h-EC_{50} = 86 mg/L and 21d-Chv = 19 mg/L for invertebrates (*Daphnia magna*). 96h-EC_{50} = 73 mg/L and 96h-Chv = 51 mg/L for algae.	*Estimates carried out for this report using EPI Suite v4.11.
Environmental classification	Harmonised classification: Not classified. Notifications: Not classified (27 notifications)	ECHA, 2014B

Environmental fate and persistence
No experimental data are available. Estimates for the physico-chemical properties of the substance obtained using the EPI Suite v4.11 program give a water solubility of 0.15 mg/L at 25°C, a vapour pressure of 8.4×10^{-21} Pa at 25°C and a log Kow of 3.83. The substance is therefore likely to adsorb to sediment and soil to some extent but will also be subject to leaching from such media.

Predictions for the biodegradability of the substance obtained using the EPI Suite v4.11 program suggest that the substance is not readily biodegradable.

Bioaccumulation potential
No experimental data are available on the bioaccumulation potential. The log Kow is estimated to be 3.83 and the BCF in fish is estimated to be up to 350 L/kg (estimates obtained using the EPI Suite v4.11 program).

Ecotoxicity
No experimental data on the ecotoxicity of this substance using standard test systems have been located. Estimates for the acute and long-term toxicity of the substance obtained using the EPI Suite v4.11 suggest that the acute $L(E)C_{50}$ is in the range 73-230 mg/L and that the long-term Chv is in the range 19-51 mg/L for fish, invertebrates and algae. These values are all above the estimated water solubility of the substance meaning that, in practice, these toxic concentrations are unlikely to be reached.

Evaluation
The available predicted data suggest that the substance is unlikely to meet the REACH Annex XIII criteria for PBT or vPvB. Although the substance is predicted to be not readily biodegradable, the potential for bioaccumulation and long-term toxicity to aquatic organisms is predicted to be low.

The substance has not yet been registered under the REACH Regulation.

4.3.17 Isoamyl p-methoxy cinnamate (CAS No. 71617-10-2)

A summary of the environmental fate and effects data for isoamyl p-methoxy cinnamate is presented in Table 40.

TABLE 40
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR ISOAMYL P-METHOXY CINNAMATE

Property	Description		Reference
isoAmyl p-methoxy cinnamate (CAS No. 71617-10-2)			
Physico-chemical data	Melting point	3.5°C	ECHA, 2014A
	Boiling point	343.5°C	ECHA, 2014A
	Vapour pressure	0.0066 Pa at 25°C	ECHA, 2014A
	Log Kow	4.78	ECHA, 2014A
	Water solubility	ca. 0.8 mg/L at 25°C	ECHA, 2014A
Potential for degradation	Weight of evidence is that the substance is readily biodegradable.		ECHA, 2014A
Bioaccumulation potential	BCF in fish is estimated to be 662 L/kg using the BCFBAF v4.1 program.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} > 1,000 mg/L in fish (based on weight of evidence and read-across). 48h-EC_{50} ~0.28 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} ca. 0.2 mg/L and 72h-NOEC ca. 0.06 mg/L for algae (*Desmodesmus subspicata*). No experimental data are available on the long-term toxicity to fish and invertebrates using standard test systems but estimates obtained using the EPIWIN v3.12 program suggest a 32d-Chv of 0.013 mg/L for fish.		ECHA, 2014A Environment Agency, 2008
Environmental classification	No harmonised classification Notifications: Aquatic Acute 1: H400 (55 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (1 notification)		ECHA, 2014B

Environmental fate and persistence

Isoamyl p-methoxy cinnamate has a water solubility of approximately 0.8 mg/L at 25°C, a vapour pressure of 0.0066 Pa at 25°C and a log Kow of 4.78 (ECHA, 2014A). The substance is therefore likely to adsorb strongly to sediment and soil but will also be subject to leaching to some extent from such media.

The substance is reported to be readily biodegradable based on a weight of evidence approach involving both data from studies with the substance itself and also read-across from related substances (ECHA, 2014A) and so would be unlikely to persist in the environment.

Bioaccumulation potential
The substance has a log Kow of 4.78 and, based on this, would have a potential for bioaccumulation. No experimental data are available on the BCF of the substance in fish but an estimated BCF of 662 L/kg, obtained using the BCFBAF v3.02 program, has been reported (ECHA, 2014A).

Ecotoxicity
The substance is not acutely toxic to fish but the 48h-EC_{50} for *Daphnia magna* is 0.28 mg/L and the 72h-EC_{50} and NOEC for algae are 0.2 mg/L and 0.06 mg/L respectively (ECHA, 2014A).

No experimental data are available for the long-term toxicity of the substance to fish and aquatic invertebrates using standard test systems, but estimates reported in Environment Agency (2008) obtained using the EPIWIN v3.12 program suggest that the long-term Chv for fish is around 0.013 mg/L.

Evaluation
The substance does not meet the REACH Annex XIII criteria for PBT or vPvB as the substance is readily biodegradable. The REACH Registration dossier for this substance also concluded that the substance was not PBT and not vPvB.

4.3.18 Benzophenone (BP) (CAS No. 119-61-9)
A summary of the environmental fate and effects data for benzophenone is presented in Table 41.

TABLE 41
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BENZOPHENONE **(BP)**

Property	Description		Reference
Benzophenone (CAS No. 119-61-9)			
Physico-chemical data	Melting point	48.5°C	ECHA, 2014A
	Boiling point	305.4°C	ECHA, 2014A
	Vapour pressure	0.257 Pa at 25°C	ECHA, 2014A
	Log Kow	3.18	ECHA, 2014A
	Water solubility	23.9 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Readily biodegradable.		ECHA, 2014A
Bioaccumulation potential	BCF in fish = 3.4-12 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} = 14.8 mg/L for fish (*Pimephales promelas*). 7d-NOEC = 2.1 mg/L for fish (embryo and sac-fry stages; *Pimephales promelas*). 48h-EC_{50} = 6.8 mg/L and 21d-NOEC = 0.2 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} = 3.5 mg/L and 72h-NOEC = 1 mg/L for algae (*Pseudokirchneriella subcapitata*).		ECHA, 2014A

Property	Description	Reference
Benzophenone (CAS No. 119-61-9)		
Environmental classification	No harmonised classification Notifications: Not classified (241 notifications) Aquatic Chronic 2: H411 (>1,000 notifications) Aquatic Acute 1: H400 (182 notifications) Aquatic Acute 1: H400 Aquatic Chronic 2: H411 (93 notifications) Aquatic Chronic 1: H410 (144 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (206 notifications) Aquatic Chronic 3: H412 (79 notifications)	ECHA, 2014B

Environmental fate and persistence
Benzophenone has a water solubility of 23.9 mg/L at 20°C, a vapour pressure of 0.257 Pa at 25°C and a log Kow of 3.18 (ECHA, 2014A). These data suggest that the substance will be relatively mobile in the environment.

Benzophenone is readily biodegradable in the manometric respirometry test (OECD 301F test guideline; ECHA, 2014A) and so is unlikely to persist in the environment.

Bioaccumulation potential
The BCF for benzophenone in fish has been determined to be in the range of 3.4-12 L/kg (ECHA, 2014A). The test was carried out using *Oryzias latipes* using an 8 week exposure period. The concentrations of benzophenone tested were 0.3 and 0.03 mg/L which are well below the water solubility of the substance. This result indicates that the substance has a low potential for bioaccumulation in aquatic systems, which would also be expected based on the log Kow of 3.18.

Ecotoxicity
Data from both acute and longer-term studies using standard test systems are available for benzophenone (ECHA, 2014A). The lowest acute $L(E)C_{50}$ is 3.5 mg/L obtained for both *Daphnia magna* and algae. The lowest longer-term result is a 21 day NOEC of 0.2 mg/L for *Daphnia magna*.

Evaluation
The substance does not meet the REACH Annex XIII criteria for PBT or vPvB. The substance is readily biodegradable, has a low potential for bioaccumulation and the long-term NOECs reported from standard ecotoxicity tests are all >0.01 mg/L. The REACH Registration dossier for this substance also concluded that the substance was not PBT or vPvB.

4.3.19 Benzophenone-12 (CAS No. 1843-05-6)

A summary of the environmental fate and effects data for benzophenone-12 is presented in Table 42.

TABLE 42
SUMMARY OF ENVIRONMENTAL FATE AND EFFECTS DATA FOR BENZOPHENONE-12

Property	Description		Reference
Benzophenone-12 (CAS No. 1843-05-6)			
Physico-chemical data	Melting point	48°C	ECHA, 2014A
	Boiling point	>275°C	ECHA, 2014A
	Vapour pressure	4.5×10^{-6} Pa at 20°C	ECHA, 2014A
	Log Kow	7.6 (estimated using CLOGP v3.42)	ECHA, 2014A
	Water solubility	<0.001 mg/L at 20°C	ECHA, 2014A
Potential for degradation	Not readily biodegradable. Hydrolysis half-life >1 year at 50°C and pH 4, 7 and 9.		ECHA, 2014A
Bioaccumulation potential	BCF in fish ≤190 L/kg.		ECHA, 2014A
Ecotoxicity	96h-LC_{50} >100 mg/L for fish (*Danio rerio*). 48h-EC_{50} >0.0038 mg/L for invertebrates (*Daphnia magna*). 72h-EC_{50} >100 mg/L and 72h-NOEC ≥100 mg/L for algae (*Desmodesmus subspicatus*). No experimental data are available on the long-term toxicity to fish and invertebrates from standard tests but estimates carried out using EPI Suite v.411 suggest a 32d-Chv [3] of 0.002 mg/L for fish and a 21d-Chv of 0.005 mg/L for invertebrates (*Daphnia magna*).		ECHA, 2014A This report
Environmental classification	No harmonised classification Notifications: Not classified (90 notifications) Aquatic Chronic 3: H412 (352 notifications) Aquatic Chronic 4: H413 (177 notifications) Aquatic Chronic 1: H410 (44 notifications) Aquatic Acute 1: H400 Aquatic Chronic 1: H410 (23 notifications)		ECHA, 2014A

Environmental fate and persistence

The water solubility of benzophenone-12 is <0.001 mg/L at 25°C (ECHA, 2014A). The substance has a vapour pressure of 4.5×10^{-6} Pa at 20°C and the log Kow is estimated to be 7.6 using the CLOGP v3.42 program (ECHA, 2014A). The substance is therefore expected to adsorb strongly onto soil and sediment and be relatively immobile in the environment.

The substance is not readily biodegradable in the CO_2 evolution test (OECD 301B test guideline, ECHA, 2014A) and does not readily hydrolyse in the environment (hydrolysis half-life >1 year determined in an OECD 111 guideline test; ECHA, 2014A).

Bioaccumulation potential
Although the substance has a relatively high log Kow value (log Kow 7.6) the BCF determined in fish is ≤190 L/kg indicating that the substance has a relatively low potential for bioaccumulation. The BCF test was carried out according to the OECD 305 test guideline using *Cyprinus carpio*. The fish were exposed to concentrations of the substance of 0.002 and 0.0002 mg/L for 60 days. The water solubility of the substance is reported to be <0.001 mg/L and so the concentrations tested may have been above the solubility of the substance in the test medium, which introduces some uncertainty into the test.

Ecotoxicity
The available short-term ecotoxicity data show that the substance is not acutely toxic at concentrations well above the water solubility of the substance (or at the highest concentration that could feasibly be tested).

No experimental data are available on the long-term toxicity to fish and aquatic invertebrates using standard test systems. Estimates obtained using the EPI Suite v4.11 program suggest that the long-term Chv could be around 0.002 mg/L for fish and 0.005 mg/L for *Daphnia magna*. These values are above the water solubility of the substance and so it is likely that these concentrations could never be reached in reality.

Evaluation
It is not clear whether the substance does or does not meet the REACH Annex XIII criteria for PBT or vPvB. The substance is not readily biodegradable and so is potentially persistent. Based on the available experimental data, the bioaccumulation potential appears to be low (fish BCF ≤190 L/kg); however, there are some uncertainties in this study. Toxic effects on aquatic organisms are predicted to occur only at concentrations in excess of the water solubility of the substance.

4.4 Conclusions on environmental hazard

The UV filters considered show a wide range of properties at room temperature, with water solubilities ranging between 6.4×10^{-7} mg/L and 236 mg/L and vapour pressures ranging between $<<10^{-7}$ Pa and 0.257 Pa. The log Kow values range from 2.96 to >10 and the substances range from readily biodegradable to potentially persistent. These ranges of properties mean that it is difficult to generalise on the expected environmental fate and behaviour of the group as a whole.

For the preliminary assessment of the environmental hazard, the properties of the substances have been compared with the criteria given in Annex XIII of the REACH regulation, which are used to identify substances that are persistent, bioaccumulative and toxic (PBT) or very persistent and very bioaccumulative (vPvB). A summary table of the outcome of this assessment for each substance is given below. The screening criteria provided in the guidance to the REACH Regulation (ECHA, 2014C) to identify substances that are potentially PBT or vPvB have also been considered in the evaluation where relevant.

TABLE 43

SUMMARY OF PRELIMINARY ASSESSMENT OF ENVIRONMENTAL HAZARD FOR THE SELECTED SUBSTANCES

Substance	PBT and vPvB properties *				
	P	B	T	vP	vB
Benzophenone-3 (CAS No. 131-57-7)	No	No	No?	No	No
Octocrylene (CAS No. 6197-30-4)	Yes	?	Yes?	Yes	?
Benzophenone-1 (CAS No. 131-56-6)	No?	No	No	No?	No
4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)	Yes?	Yes?	Yes?	Yes?	Yes?
2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)	Yes?	Yes?	No?	Yes?	Yes?
Titanium dioxide (CAS No. 13463-67-7)	N/a	N/a	N/a	N/a	N/a
Butyl methoxy-dibenzoylmethane (CAS No. 70356-09-1)	Yes	?	No?	Yes	?
Ethylhexyl salicylate (CAS No. 118-60-5)	No	?	Yes?	No	?
Ethylhexyl triazone (CAS No. 88122-99-0)	Yes	?	?	Yes	?
Bis-ethylhexyloxyphenol methoxyphenyl triazin (CAS No. 187393-00-6)	Yes	?	?	Yes	?
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)	Yes	No	No	Yes	No
Diethylhexyl butamido triazone (CAS No. 154702-15-5)	Yes	No	No?	Yes	No
Ethylhexyl methoxycinnamate (CAS No. 5466-77-3)	No	No	Yes?	No	No
Homosalate (CAS No. 118-56-9)	Yes?	?	Yes?	Yes?	?
Drometrizol trisiloxane (CAS No. 155633-54-8)	Yes?	?	?	Yes?	?
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)	Yes?	No	No?	Yes?	No
isoAmyl p-methoxy cinnamate (CAS No. 71617-10-2)	No	No?	No?	No	No?
Benzophenone (CAS No. 119-61-9)	No	No	No	No	No
Benzophenone-12 (CAS No. 1843-05-6)	Yes	?	No?	Yes	?

* Preliminary evaluation based on the available data. A ? indicates areas with uncertainty (related to the lack of data, the use of estimated data or resulting from uncertainty in interpretation of the available data). N/a = not applicable.

Based on the available data, the following tentative conclusions can be reached:

- Substances that are unlikely to meet the Annex XIII criteria for PBT or vPvB.
  - Benzophenone-3 (BP-3) (CAS No. 131-57-7)
  - Benzophenone-1 (CAS No. 131-56-6)
  - Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)
  - Diethylhexyl butamido triazone (CAS No. 154702-15-5)

    - Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3) [note: substance on the European Commission Rolling Action Plan (CoRAP) for the REACH Regulation where the PBT properties are being considered further]
    - Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)
    - Isoamyl p-methoxycinnamate (CAS No. 71617-10-2)
    - Benzophenone (BP) (CAS No. 119-61-9)

- Substances that potentially meet the Annex XIII screening criteria for PBT and vPvB.
    - 4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)

- Substances that potentially meet the Annex XIII screening criteria for vPvB.
    - 2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)

- Substances for which no conclusion on PBT or vPvB could be reached.
    - Octocrylene (OC) (CAS No. 6197-30-4) [note: substance on the EU CoRAP for the REACH Regulation where the PBT and vPvB properties are being considered further]
    - Titanium dioxide (CAS No. 13463-67-7) [note: substance on the EU CoRAP for the REACH Regulation where the vPvB properties are being considered further]
    - Butyl methoxy-dibenzoylmethane (BMDBM) (CAS No. 70356-09-1)
    - Ethyl salicylate (CAS No. 118-60-5)
    - Ethylhexyl triazone (CAS No. 88122-99-0)
    - Bis-ethylhexyloxyphenol methoxyphenyl triazine (BEMT) (CAS No. 187393-00-6)
    - Homosalate (HMS) (CAS No. 118-56-9)
    - Drometrizol trisiloxane (CAS No. 155633-54-8)
    - Benzophenone-12 (CAS No. 1843-05-6)

Potential endocrine disruptive properties of the substances are described in the health effect section (section 5), since these effects generally raise concern for both human health and the environment and therefore are considered together.

It is important to note that the data used in this evaluation have been taken at face value and have not undergone a detailed validation as part of this project.

5. Health hazard

5.1 Introduction

Nineteen substances fulfilling one or more of the following criteria presented in section 3.3 have been selected for health hazard assessment:

- presence in cosmetics identified by shop survey – in particular sunscreen products
- occurrence in human urine or breast milk
- occurrence in drinking water
- presence in the aquatic environment or biota
- potential endocrine disrupting properties
- the exposure from cosmetics evaluated as high
- presence in other product groups with direct or potentially high exposure (textiles, paints, food packaging).

The health hazard assessment is intended to provide an overview of the toxicity of the selected UV filters and absorbers and to provide an input to the risk assessment and the calculation of the margin of Safety (MOS)[32]. It is important to note that the data used in this evaluation have been taken at face value and have not undergone a detailed validation as part of this project.

Of the 19 substances that have been selected for the health hazard assessment according to the criteria presented in section **Fejl! Henvisningskilde ikke fundet.**, 16 substances are approved UV-filters listed in Annex VI to the Cosmetics Regulation. Fourteen of the sixteen UV filters have been identified as part of the market survey of cosmetic products and one of the substances not approved as UV filter has also been found in cosmetics where it is assumed to be added as a UV absorber.

Furthermore, the substances are identified in various other product types based on information in the literature, from manufacturer/supplier websites or information received directly from industry stakeholders. Product types include textiles, toys, the group of paints, lacquers, adhesives and sealants, and printing inks for e.g. plastics and food contact materials. For details about the individual substances, reference is made to Chapter 2 and Table 20. Presence of the substances in other product types can, however, not be excluded based on the present survey. In addition, 5 of the 19 substances (BP-3, OC, 4-MBC, OD-PABA and OMC) have been identified in biomonitoring studies, in drinking water and in biota and the aquatic environment. HMS has been identified in biomonitoring studies and in biota and the aquatic environment, BMDBM has been identified in biota and in the aquatic environment, and BP in drinking water.

The hazard assessment of the selected substances is based on information provided in the newest opinions from the Scientific Committee on Consumer Safety (SCCS) where available, results of a literature search in PubMed and open search for information on specific endpoints on the Internet. Review articles/documents focusing on the individual endpoints are prioritised in the hazard assessment where no recent SCCS opinions are available. Where sufficient data have not been

[32] The Margin of Safety (MOS) expresses the ratio between the No Observed Adverse Effects level (NOAEL) (or NOEL) for the critical effect and the theoretical, predicted, or estimated exposure dose or concentration. It is generally accepted that MOS should at least be 100 to conclude that a substance is safe for use according to WHO and the SCCS Notes of Guidance (SCCS, 2012). (See also Chapter 6)

identified, information from REACH registration dossiers published by ECHA has been considered if available. It should, however, be noted that only limited information is presented from the publicly available summaries of the confidential substance registration reports. Furthermore, the information provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. In most cases where this information is used, only key studies with a reliability score[33] of 1 or 2, as evaluated by the registrant, have been considered.

Since endocrine disruptive properties of substances may give rise to a concern for both environment and human health, the evaluation of endocrine disruptive properties are (if relevant) described collectively in the end of each substance-specific section.

In summary, the following data sources have been used:

- Opinions from the Scientific Committee on Consumer Safety (SCCS) where available.
- Information identified through literature search in PubMed and on the Internet where a newer SCCS is not available.
- The publicly available registration dossiers for the substances submitted by industry under the EU REACH Regulation and available on the website of the European Chemicals Agency (ECHA). This information includes unpublished study summaries submitted by industry, in response to the standard data requirements of the REACH Regulation. Data from key studies in the registration dossiers have been preferred.
- The ECHA classification and labelling inventory (ECHA, 2014B) providing information on harmonized classification of substances and industry notified classifications for substances without a harmonized classification. In the case of industry classification, the number of notifications for each combination has been taken onto consideration, and the classifications mentioned by most notifiers are mentioned.

As for the environmental assessment, an extensive literature review has not been possible within the framework of this project and a very detailed assessment of available primary literature is not provided. The focus has been to summarise and describe all relevant endpoints, critical effects of the substances and available related no observed adverse effect levels (NOAELs) as input for the following risk assessment.

5.2 Data availability

Information on the health hazards is available for all of the selected substances considered, although the amount of information available varies considerably and does not cover all endpoints for all substances. For six approved UV filters, available scientific opinions are considered sufficiently updated and are included in the evaluation, and in the case of more recent opinions, these have been used as a primary source. In addition, information from registration dossiers has been extensively referenced. For the substance drometrizol trisiloxane, which is pre-registered, little information has been identified and the components of the substance are therefore also discussed separately.

5.3 Health hazard

In the following subsections, the substance evaluation is presented with a summary first of the relevant endpoints and NOAELs selected for the subsequent risk assessment. The background for the health hazard summary is presented in a tabular form after the summary. Information on health classification of the substances together with the REACH registration status is provided as part of

[33] Reliability score 1 = reliable without restrictions; Reliability score 2 = reliable with restrictions

the summary. The tables are organized to address the main effects of the substances. Information on endocrine disruption is presented in the end of each substance-specific section.

5.3.1 Benzophenone-3 (Oxybenzone, BP-3) (CAS No. 131-57-7)

No harmonised classification is available. 1152 CLP notifications have been submitted. 827 have suggested Skin Irrit. 2 (H315) and Eye Irrit. 2 (H319), and 820 have suggested STOT SE 3 (H335). 89 have suggested "not classified". (ECHA, 2014B). The substance is registered under REACH.

The following section is based on two SCCP opinions (SCCP, 2006; 2008a). Benzophenone-3 (BP-3) appeared to be well-absorbed in rats dosed orally and dermally. Toxicokinetic studies indicate that BP-3 is readily metabolised with excretion of the metabolites as free and conjugated forms predominantly in the urine in the rat, while in the mouse the faecal route appeared to be equally important (SCCP, 2006).

In an *in vitro* dermal absorption study, the mean dermal absorption was 3.1% of the applied dose for a sunscreen containing the maximum requested BP-3 concentration of 6%. The mean dermal absorption for a sunscreen with a BP-3 concentration of 2% was 4.0% of the applied dose (o/w or w/o) (SCCP, 2008a). The SCCP used the mean value plus 2 standard deviations, i.e. a dermal absorption of 9.9% (6% formulation) and 8.0% (2% formulation) for the calculation of the Margin of Safety (MOS) (SCCP, 2008a). The authors of this report agree with the evaluation of the SCCP; a dermal absorption of 10% will be used for the MOS calculation for use of BP-3 in sunscreens and of 8% for other cosmetic formulations.

The SCCP considered BP-3 to be of low acute toxicity, not to be irritating to the skin and the eyes, not to be photoirritating to the skin, not to be a skin sensitiser, to be a photoallergen, and not to possess (photo)mutagenic or (photo) genotoxic properties (SCCP, 2006).

Based on the subchronic oral repeated dose toxicity studies performed in rats and mice, a no observed adverse effect level (NOAEL) of 411 mg/kg bw/day was concluded by the submission authors (SCCP, 2006); the SCCP did not conclude on a NOAEL for repeated dose toxicity following oral administration of BP-3. Based on the subchronic dermal repeated dose toxicity studies performed in rats and mice, a NOAEL of 200 mg/kg bw/day was concluded by the submission authors (SCCP, 2006); the SCCP did not conclude on a NOAEL for repeated dose toxicity following topical application of BP-3 (SCCP,2006).

Based on a well-described teratogenicity study in rat, a NOAEL for maternal and developmental toxicity of 200 mg/kg bw/day was concluded (SCCP, 2006). The SCCP used this NOAEL for the calculation of the MOS (SCCP, 2008a), and this value will also be used for the MOS calculation in this report. The authors of this report can agree with the evaluation of the SCCP; a NOAEL of 200 mg/kg bw/day will be used for the MOS calculation.

TABLE 44
HEALTH PROPERTIES OF BENZOPHENONE-3 (BP-3) (CAS NO. 131-57-7)

Endpoint	Description	Reference
Benzophenone-3 (BP-3) (CAS No. 131-57-7)		
Toxicokinetics	In an *in vitro* dermal absorption study (draft OECD TG 428) with pig skin the mean dermal absorption level was 19.3 µg/cm² or 3.1% of the applied dose for a sunscreen (o/w or w/o) containing the maximum requested BP-3 concentration of 6% and 4.0% of the applied dose for a sunscreen (o/w or w/o) containing a BP-3 concentration of 2%. BP-3 dosed orally (3.257 mg/kg bw) and dermally (approximately 0.2-3.2 mg/kg bw) to rats appeared to be well-absorbed and urinary secretion clearly showed to be the major route of elimination,	SCCP, 2008a SCCP, 2006

Endpoint	Description	Reference
	followed by the faecal route. Only trace amounts appeared to be measured in tissues after 72 hours. Toxicokinetic studies indicated that BP-3 is readily biotransformed into its three major metabolites 2,4-dihydroxybenzone (DHB), 2,2'-dihydroxy-4-methoxybenzone (DHMB) and 2,3,4-trihydroxybenzophenone (THB), which have been identified in their free and conjugated (glucuronidated or sulphonated) forms. Excretion in the rat primary occurred via the urine, while in the mouse the faecal route appeared to be equally important. In both species and for both exposure routes (oral and dermal), BP-3 was rapidly absorbed, metabolised and distributed.	SCCP, 2006
Acute toxicity	BP-3 was considered to display a low acute toxicity profile with oral and dermal LD50-values exceeding the classification limit of 2000 mg/kg.	SCCP, 2006
Irritation and corrosivity	BP-3 was not considered as being irritating to the skin and the eyes. The human data with the compound under in-use conditions did not provide any indication of skin and eye irritation due to BP-3. BP-3 has been extensively tested for its photoirritating potential *in vitro* during the validation of the 3T3 NRU PT test and was found negative in the majority of cases.	SCCP, 2006
Skin sensitisation	Two animal tests (a guinea pig Magnusson Kligman Maximisation test and a LLNA (OECD TG 429)) indicated that BP-3 is non-sensitising. A number of reports of clinical trials with regard to the photoallergenic potential of UV-filters in general were submitted. In each of these, a number of clear positive reactions to BP-3 are described. In the opinion, some extra references on this issue have been added by the SCCP to the ones included in the submission. Looking at the positive photoallergic reactions to BP-3, it must be emphasized that the study population in all tests consisted of patients with a suggested history of photocontact allergy. As a general rule, results of clinical trials should be followed up in order to detect potential trends towards an increasing incidence of (photo)allergic reactions to specific compounds. In the case of BP-3, the presented publications clearly indicate that the UV-filter is a photoallergen.	SCCP, 2006 SCCP, 2006, 2008a
Subchronic/ repeated dose toxicity	After repeated oral administration of BP-3 in rats and mice, the most frequently encountered adverse effects consisted of some unspecific signs of systemic toxicity in the form of reduced food consumption and retarded body weight gain, together with some effects on the identified target organs being the kidney and the liver. These effects were partly associated with changes in clinical chemistry. Very often the most susceptible parameter was the increase in liver weight. The latter, however, without any histopathological correlate, was not considered by the submission authors to reflect an adverse effect per se but should be considered as an adaptive metabolic response which is known to be reversible. Therefore, according to the submission authors, the oral NOAEL for subchronic toxicity corresponded to 411 mg/kg bw/day. With regard to the results of the dermal repeated dose studies, a	SCCP, 2006

Endpoint	Description	Reference
	dermal NOAEL of 200 mg/kg bw/day was put forward, on the assumption that deviations without dose-response relationship and without correlated histopathological findings (e.g. the decreased reticulocyte count, increased relative kidney weight, increased platelet count and whole blood cell count in the 90-day dermal study in rat) should not be taken into account. The SCCP noted that, taking the complete set of oral and dermal subacute and subchronic toxicity studies together, the choice of the dosages may raise some questions. In the oral studies, the dosages appeared to be extremely high (up to 20,796 mg/kg bw/day) whereas the dosage levels in the dermal studies appeared to be very low (down to 7 mg/kg bw/day). Even though the results indicated that BP-3 causes adverse effects at lower dosages through the dermal route compared to oral administration, the dermal dosages remained at the low side and this was also confirmed by the absence of clear toxicity signs at the highest levels tested (200 mg/kg bw/day).	
Mutagenicity/ genotoxicity	The presented *in vitro* and *in vivo* assays indicate that BP-3 does not possess (photo) mutagenic or (photo) genotoxic properties.	SCCP, 2006
Carcinogenicity	No data.	
Reproductive toxicity	A well-described teratogenicity study in rat (OECD TG 414) showed BP-3 to be non-teratogenic under the conditions of the test. Only at the highest dosage level (1000 mg/kg bw/day), which also caused maternal toxicity, some skeletal aberrations were noted. The NOAEL value for maternal and developmental toxicity was 200 mg/kg bw/day. Instead of a 2-generation study, the submission contained some specific reproductive toxicity parameter measurements made at the end of the subchronic toxicity studies described above, together with the description of a reproduction screening assay according to the "Continuous Breeding Protocol". Out of these results, a NOAEL value of 400 mg/kg bw/day for reproductive toxicity was extracted.	SCCP, 2006
Other effects	BP-3 interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	Schiffer et al., 2014

Endocrine disruption

BP-3 is on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) and on the SIN list (SIN list database, 2014). In 2012, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Hass et al., 2012). Based on this evaluation, the substance can be considered a suspected endocrine disruptor with a concern for both human health and the environment. Under REACH the substance is on the CoRAP list and currently undergoing substance evaluation (started in 2014), with an initial concern for endocrine disruptive effects. This can lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH or a conclusion that the available data are adequate to conclude that the substance is not of concern. This is expected to be resolved in 2015.

5.3.2 Octocrylene (OC) (CAS No. 6197-30-4)

No harmonised classification. Notified classifications do not include health classifications (ECHA, 2014B).

The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

Octocrylene is absorbed through the gastrointestinal tract (ECHA, 2014A). In *in vitro* and *in vivo* dermal absorption studies with human skin the recovery in the stratum corneum after 30 minutes (as% of applied dose) was 2.8±1.6 and 4.8±1.4, respectively. The *in vitro* quantification of octocrylene in stratum corneum, epidermis, dermis, receptor fluid and washing solution after 16 hours of exposure was 10.3±6 µg/cm²; 0.2±0.4 µg/cm2; 0.01±0.4 µg/cm2; below LOD and 90.1±6%, respectively (ECHA, 2014A). The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of octocrylene in sunscreens and other cosmetic formulations.

According to the registration dossier (ECHA, 2014A) octocrylene is of low acute toxicity, not irritating to the skin and the eyes, not a skin sensitiser, and does not possess mutagenic or genotoxic properties. In a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 175 mg/kg bw/day was concluded (ECHA, 2014A).

In a dermal repeated dose toxicity study performed in rabbits, effects were observed at the lowest dose level tested (130 mg/kg bw/day) (ECHA, 2014A).In a teratogenicity study in rat, a NOAEL for maternal and developmental toxicity of 100 and 1000 mg/kg bw/day, respectively, was concluded (ECHA, 2014A).

The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 175 mg/kg bw/day will be used for the preliminary MOS calculation.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A). Swedish researchers have recently published a study showing that OC is moderately sensitizing in a Local Lymph Node Assay (LLNA). This result was supported by clinical studies showing that OC is both a contact allergen and a photocontact allergen (Karlsson et al, 2011)

TABLE 45
HEALTH PROPERTIES OF OCTOCRYLENE (OC) (CAS NO. 6197-30-4)

Endpoint	Description	Reference
Octocrylene (CAS No. 6197-30-4)		
Toxicokinetics	Octocrylene is absorbed through the gastrointestinal tract. The absorption and distribution of octocrylene was investigated in an *in vitro* dermal penetration study with human skin and an *in vivo* absorption study in human subjects (n=8). Octocrylene was applied to human skin in a dose of 3 mg/cm² (oil in water emulsion) for 30 min or 16 hours. The *in vitro* and *in vivo* recovery in the stratum corneum after 30 min (as% of applied dose) was 2.8±1.6 and 4.8±1.4, respectively. The *in vitro* quantification of octocrylene in stratum corneum, epidermis, dermis, receptor fluid and washing solution after 16 hours of exposure was 10.3±6 µg/cm²; 0.2±0.4 µg/cm²; 0.01±0.4 µg/cm²; below LOD and 90.1±6%, respectively.	ECHA, 2014A

Endpoint	Description	Reference
Acute toxicity	Acute oral LD50 > 5,000 mg/kg bw for rats (OECD TG 401). Acute dermal LD50 > 2,000 mg/kg bw for rats (OECD TG 402).	ECHA, 2014A
Irritation and corrosivity	In a primary skin irritation study (OECD TG 404), New Zealand White rabbits (4 animals) were exposed to 0.5 mL of 1, 10, 25, 50 or 100% (w/w) for 4 hours. No erythema or oedema were observed (Draize score 0 for both). In an eye irritation study OECD TG 405), rabbits (4 animals) were exposed to 0.1 mL neat octocrylene for 24 hours. No eye reactions were noted in any animal at any time (Draize score 0 for all endpoints).	ECHA, 2014A
Skin sensitisation	In an *in vivo* guinea pig maximization test (OECD TG 406) the intradermal induction caused intense erythema and swelling in all test group animals. After the epicutaneous induction, incrustation, partially open (caused by the intradermal induction) could be observed in addition to moderate and confluent erythema and swelling in all test group animals. No skin reactions were observed after challenge, neither in the control nor in the test group. Moderate skin sensitization was demonstrated in the local lymph node assay (LLNA) where reactions with amines such as lysine, but not with thiols such as cysteine were observed. Results from 5 patch tests and 18 photopatch tests indicated both contact and photocontact allergenicity.	ECHA, 2014A Karlsson et al., 2011
Sub-chronic/ repeated dose toxicity	In an oral sub-chronic study (OECD TG 408), Wistar rats (10 animals/sex/group) were given 58, 175, 340 or 1,085 mg/kg bw/day in the diet for 3 months. Body weight, body weight gain and food consumption was lower in the high dose group compared to control. Effects on haematology, clinical chemistry, urinalysis, organ weights and pathology were seen in the 340 and 1,085 mg/kg bw/day groups. A NOAEL of 175 mg/kg bw/day was concluded. In a percutaneous subchronic toxicity study New Zealand White rabbits (5 animals/sex/group) were applied doses of 130, 264 or 534 mg/kg bw/day 5 days/week for 91 days (total of 65 applications). Dose-dependent hind limb alopecia and skin irritation at the site of compound application (back) and lower body weight gain was observed for all dose-levels.	ECHA, 2014A
Mutagenicity/ genotoxicity	Octocrylene was negative in an *in vitro* bacterial reverse mutation assay (OECD TG 471) in *S. typhimurium* strains TA 1535, TA 1537, TA 98 and TA 100 and *E. Coli* strain WP2 uvr A with or without metabolic activation at concentrations between 4 and 2,500 µg/plate. Octocrylene was negative in two *in vitro* bacterial reverse mutation assays (one performed according to OECD TG 471) in *S. typhimurium* strains TA 1535, TA 1537, TA 98 and TA 100 with or without metabolic activation at concentrations of 20, 100, 333, 500, 1,000, 2,500, 3,333, 5,000 and 10,000 µg/plate. Octocrylene was negative in three *in vitro* mammalian chromosome aberration tests (two performed according to OECD TG 473) with Chinese hamster lung fibroblasts (V79) and Chinese hamster ovary cells (with or without metabolic activation) at concentrations of 3.75 to 90 µg/mL and up to 100 µg/mL, respectively.	ECHA, 2014A

Endpoint	Description	Reference
	Octocrylene was negative in two *in vitro* mammalian cell gene mutation assays with mouse lymphoma L5178Y cells (one performed according to OECD TG 476) at concentrations of 12.5 to 200 µg/mL (with or without metabolic activation); 28 to 380 µg/mL (without metabolic activation) and 6.7 to 89 µg/mL (with metabolic activation). Octocrylene was negative in an *in vivo* micronucleus assay (bone marrow cells) performed in mice (oral application 500, 1,000, 2,000 mg/kg bw) (OECD TG 474).	
Carcinogenicity	No data	ECHA, 2014A
Reproductive toxicity	In a developmental toxicity study (OECD TG 414), Wistar rats (25 females/group) were given 100, 400 or 1,000 mg/kg bw/day by gavage on day 6 to 15 of gestation. Substance induced salivation was observed in the high-dose group and relative liver weights were higher in the high and the middle-dose groups compared to control. NOAELs of 100 mg/kg bw/day and 1,000 mg/kg bw/day for maternal and developmental toxicity, respectively, were concluded. CD-1 mice (12 animals/sex/group) were given 0, 100, 300 or 1,000 mg/kg bw/day by gavage on days 8 through 12 of gestation. No statistically significant treatment related adverse effects were observed. NOAELs for maternal and developmental toxicity of >1,000 mg/kg bw/day were concluded. Pregnant New Zealand White rabbits (17 females/group) were applied doses of 0, 65 or 267 mg/kg bw/day (in a mixture of petrolatum and C1-C15 alkylbenzoate) dermally on days 6 to 18 of gestation. No treatment related adverse effects were observed. A NOAEL > 267 mg/kg bw/day for maternal and developmental toxicity was concluded. In a percutaneous subchronic toxicity study New Zealand White rabbits (5 males/group) were applied doses of 130, 264 or 534 mg/kg bw/day (corresponding to solutions of 7.5, 15 and 30% w/w, respectively) 5 days/week for 91 days (total of 65 applications). No treatment related effects on epididymis or testes were observed.	ECHA, 2014A
Other effects	Octocrylene interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	Schiffer et al., 2014

Endocrine disruption

Octocrylene is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was that there is not enough data to conclude whether the substance has a potential for endocrine disruption or not. Further testing of octocrylene has been requested after substance evaluation under REACH in order to resolve a concern for endocrine disruptive effects. Until these data become available (deadline for the registrants to submit information on the new studies to ECHA is in September 2016), the substance can be considered as a suspected endocrine disruptor with concern for human health and environment.

5.3.3 Benzophenone-1 (BP-1) (CAS No. 131-56-6)

No harmonised classifications. 1179 notifiers have submitted a CLP notification. 827 notifiers have suggested Skin Irrit. 2, 973 have suggested Eye Irrit. 2, and 823 have suggested STOT SE 3 (H335). Skin Sens. 1 (H317) is suggested by 93 (ECHA, 2014B).
Only limited data have been available for the health assessment of benzophenone-1 (BP-1). For endpoints where no other data were identified in the open literature, the summary is based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

The substance is used as a UV-filter itself and is also a metabolite of BP-3, where the methoxy group (R-O-CH_3) has been substituted by a hydroxyl group (R-OH) (Jeon et al., 2008). BP-1 is therefore a little less lipophilic than BP-3. Data on absorption, distribution and excretion have not been available. The authors of this report thus cannot conclude on a dermal absorption and as a worst case a dermal absorption of 100% will be used for the preliminary MOS calculation for use of BP-1.

Data on irritation and sensitisation show that BP-1 is not irritating nor sensitizing at concentrations that may be found in cosmetic products. The toxicity studies available indicate a very low acute toxicity of BP-1 (LD50, rat, oral: 8600 mg/kg bw), and low subchronic toxicity (NOAEL, rat, oral: 236 mg/kg bw/day). BP-1 is, like other benzophenones, not mutagenic. The lowest effect levels were determined for reproductive toxicity with lowest observable adverse effect levels (LOAELs) between 100-625 mg/kg and NOAELs between 100-250 mg/kg.

The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 236 mg/kg bw/day for repeated dose toxicity (oral) is suggested by the REACH registrant and will be used for the preliminary MOS calculation.

TABLE 46
HEALTH PROPERTIES OF BENZOPHENONE-1 (BP-1) (CAS NO. 131-56-6)

Endpoint	Description	Reference
Benzophenone-1 (BP-1) (CAS No. 131-56-6)		
Toxicokinetics	No ADME study of BP-1 was identified. Jeon et al. (2008) studied the toxicokinetics of 2-hydroxy-4-methoxybenzophenone (BP-3) in rats (7 per dose group) following oral administration (no information on GLP compliance or test guidelines). BP-1 was identified as a major metabolite of BP-3 in rat blood. BP-1 was cleared from the blood 24 h after administration, but the concentration of the metabolite decreased much more slowly over time compared to the parent compound. BP-1 can be further metabolised to 2,3,4-trihydroxy benzophenone (CAS No. 1143-72-2).	Jeon et al., 2008
Acute toxicity	LD50, rat, oral: 8,600 mg/kg bw (interpretation: practically nontoxic). No information on GLP compliance or test guidelines.	ECHA, 2014Ab
Irritation and corrosivity	Rabbit, skin, 24 h: Benzophenone-1, -4, and -6 were minimally irritating (PII = 0.25-0.50) when applied as 16% solutions in dimethyl phthalate (DMP) and non-irritating at 8% in DMP and at 16% in petrolatum. Study according to FHSLA procedure, no information on GLP compliance. Rabbit, eye, 0.1 mL, single exposure according to OECD TG 405: Benzophenones-1, -2, and -4 were slightly to moderately irritating at 100% concentration.	Liebert, 1983

Endpoint	Description	Reference
Skin sensitisation	Benzophenones were tested for potential irritation and sensitization to human skin. In general, the ingredients were reported to be non-irritating and non-sensitizing at concentrations higher than those found in cosmetics. Study according to Shelanski RIPT with no information on GLP compliance.	Liebert, 1983
Subchronic/ repeated dose toxicity	Rat, oral, 90 day test, undefined organ, undefined (systemic) effect: NOAEL 236 mg/kg bw/day (nominal) Result produced from read-across based on grouping of substances (category approach).	ECHA, 2014A
Mutagenicity/ genotoxicity	Ames Salmonella/Mammalian-Microsomal Assay according to OECD TG 471: The Ames Salmonella/Mammalian-Microsomal Assay was used to test BP-1 for mutagenicity. BP-1 was, like the other benzophenones, non-mutagenic when assayed directly. BP-1 was also non-mutagenic with metabolic activation.	Liebert, 1983
Carcinogenicity	No data	
Reproductive toxicity	Review study of several oral, subcutaneous and intra-peritoneal exposure studies with female rats: LOAELs between 100-625 mg/kg and NOAELs between 100-250 mg/kg have been found for increased uterus weight in the uterus assay, with the differences probably illustrating the differences in animals strain and dosing scheme being used. A NOAEL of 100 mg/kg bw/day was determined for 3-day exposure of rats.	ECHA, 2014A
Other effects	No data	

Endocrine disruption

BP-1 is on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) and on the SIN list (SIN list database, 2014). In 2012, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Hass et al., 2012). Based on this evaluation, the substance can be considered a suspected endocrine disruptor with a concern for both human health and the environment. Under REACH, a Risk Managemenet Option Analysis is currently under development, with an initial concern for endocrine disruptive effects. Whether this will lead to a need for futher evaluation of the substance or a proposal to identify the substance as an endocrine disruptor under REACH remains to be seen. The substance can currently be considered as a suspected endocrine disruptor of concern for human health and the environment.

5.3.4 4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)

No harmonised classification. Most notified classifications do not include health classifications. Repr. 2 is suggested by 23 out of 271 notifiers (ECHA, 2014B). The substance 4-MBC is pre-registered under REACH.

SCCP has published a revised opinion on the substance in 2008, from which most of the data presented here are taken (SCCP, 2008b).

Dermal absorption is estimated to be negligible in a study by Søeborg et al. (2007), while the most recent data presented in the SCCP opinion indicate a dermal uptake of 1.1%. The opinion also presents data on distribution and metabolism of the substance, which is used for the determination of the toxicokinetic factor in the calculation of the MOS. 4-MBC is mainly excreted unchanged via faeces, while the metabolites are excreted via the urinary route.

Acute toxicity showed to be very low with LD50 values (for several species) exceeding 2000 mg/kg bw following oral exposure. No irritation or skin sensitization could be documented for 4-MBC.

The results from several repeated exposure studies are summarised in the opinion. The lowest NOAEL available based on thyroid effects in the rat following oral exposure is 25 mg/kg bw/day. The lowest available NOAEL following dermal exposure of rats was 400 mg/kg bw/day.

The available data suggest no genotoxicity, mutagenic potential or phototoxicity of 4-MBC. A teratogenicity study revealed a NOAEL for developmental effects of 10 mg/kg bw/day, based upon the observation of some retardation of ossification at 30 mg/kg bw/day (exposure route and duration not specified, but presumably based on oral exposure). However, these effects, which are background for the above-mentioned NOAEL, are not clearly related to the test substance and the data obtained are not statistically significant. It is therefore concluded in the SCCP opinion that the NOAEL value of 25 mg/kg/day of the 90-day oral toxicity study in the rat is the appropriate value to be used in the calculation of the MOS and the authors of this report agree with the evaluation of the SCCP opinion (SCCP, 2008b).

In conclusion, a NOAEL of 25 mg/kg bw/day will be used for the MOS calculation.

TABLE 47
HEALTH PROPERTIES OF 4-METHYLBENZYLIDENE CAMPHOR (4-MBC) (CAS NO. 36861-47-9)

Endpoint	Description	Reference
4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)		
Toxicokinetics	The study assessed the risk to humans of harmful substances, including 4-MBC, in semisolid topical dosage forms applied topically to normal skin and broken skin. Experiments were carried out according to OECD "Guidance document for the conduct of skin absorption studies" using *in vitro* pig skin membranes. Cream was applied twice a day to the membranes at a concentration of approximately 2 mg/cm². A flux of 1.19 ± 0.43 ng/cm²/h was determined for healthy skin (no result for broken skin).	Søeborg et al., 2007
	When applied at 5% in an oil-in-water emulsion on the forearm of 6 volunteers, 4-MBC displayed a dermal absorption value of 1.9%. However, due to the many shortcomings in the presented study, a final conclusion on the dermal absorption of 4-MBC could not be drawn. A dermal absorption study according to COLIPA Guideline for Percutaneous Absorption/Penetration (1995) with pigskin, 24 h exposure, resulted in a dermal absorption value of 1.96 µg/cm² (mean values from dermis and epidermis, corresponding to 1.1%) following application of 178 µg/cm² (mean value) substance. Plasma concentrations of 4-MBC in female rats were measured on day 1 and day 90 in a 90 day dermal study in rat. Concentrations were measured every 0.5, 1, 2, 4, 8, and 24 h following exposure and the concentrations peaked after 1 and 8 h. Maximum plasma concentration were lower at day 90 compared to day 1, suggesting that an enzyme induction phenomenon occurs in the case of repeated	SCCP, 2008b

Endpoint	Description	Reference
	exposure.	
	Plasma levels of 4-MBC measured in a single dose dermal study in human volunteers (3 males and 3 females) following exposure to a 4% sunscreen product (dose of approx. 22 mg/kg bw) resulted in peak concentration 6 h after application. The following metabolites were identified: MET-2 [3-(4-carboxybenzylidene)-camphor] and MET-1 [3-(4-carboxybenzylidene)-6-hydroxycamphor]. Plasma concentrations of the metabolites peaked 12 – 24 h after application. In human subjects, only a small percentage of the dermally applied dose of 4-MBC was recovered in the form of metabolites in urine, partly as glucuronides. The obtained results suggest a more intensive biotransformation of 4-MBC in rats as compared to humans after dermal application and a poor absorption of 4-MBC through human skin.	SCCP, 2008b; Schauer et al., 2006
	The toxicokinetics and biotransformation of 4-MBC were characterized in rats after oral administration. Male and female rats (n = 3 per group) were administered single oral doses of 25 or 250 mg/kg bw. Biotransformations and excretion was characterized from blood and urine analysis. Urinary excretion of 4-MBC-metabolites represents only a minor pathway of elimination for 4-MBC, since most of the applied dose was recovered in faeces. The results show that absorbed 4-MBC undergoes extensive first-pass biotransformation in rat liver resulting in very low blood levels of the parent 4-MBC. Enterohepatic circulation of glucuronides derived from the two major 4-MBC metabolites may explain the slow excretion of 4-MBC metabolites with urine and the small percentage of the administered doses recovered in urine.	Völkel et al., 2006
Acute toxicity	4-MBC displays low acute toxicity, with oral and dermal LD50 values of more than 2000 mg/kg measured in several species.	SCCP, 2008b
Irritation and corrosivity	No irritating effects were reported after skin or eye contact with 4-MBC.	SCCP, 2008b
Skin sensitisation	Neither in guinea pigs, nor in human subjects, sensitisation effects were noted when 4-MBC was applied at concentrations of 3% and 5%, respectively.	SCCP, 2008b
Subchronic/ repeated dose toxicity	In oral 28 day and 90 day studies, 4 -MBC was administered daily to rats at dosage levels ranging from 25 to 312 mg/kg bw/day. The effects noted were mainly situated at the level of the thyroid axis, with deviations of normal thyroxine (T4), triiodothyronine (T3) and/or thyroid-stimulating hormone (TSH) levels, thyroid gland weight, etc. The oral NOAEL (90d - rat) based upon thyroid effects showed to be 25 mg/kg bw/day. When dermally applied to the rat skin for 90 days at reported dosage levels of 0, 100, 400, and 2000 mg/kg bw/day, some slight thyroid effects were observed at 400 mg/kg bw/day, while the animals of the high dosage group had to be sacrificed due to the severity of the local effects (epidermal lesions, wounds, necrosis, etc.). The authors considered 400 mg/kg bw/day as the dermal NOAEL of	SCCP, 2008b

Endpoint	Description	Reference
	4-MBC and 100 mg/kg bw/day as its dermal NOEL.	
Mutagenicity/ genotoxicity	The bacterial mutation (Ames) test and the *in vitro* chromosomal aberration test were both negative.	SCCP, 2008b
Carcinogenicity	No data	
Reproductive toxicity	A teratogenicity study revealed a NOAEL value for developmental effects of 10 mg/kg bw/day, based upon the observation of some retardation of ossification at 30 mg/kg bw/day. There was no evidence of teratogenesis. When tested in a one-generation reproduction toxicity study, 4-MBC displayed some minor thyroid effects at the highest dosage levels tested (25 and 50 mg/kg bw/day), though not at the lowest one (12.5 mg/kg bw/day). The study authors did not consider any of the observed effects relevant.	SCCP, 2008b
Other effects	Photo-induced toxicity The phototoxicity of 4-MBC was assessed in mice and humans and showed to be negative, while studies in guinea pig and human volunteers revealed the compound to be non-photosensitising at 4%. *In vitro* photomutagenicity studies (Ames test and chromosomal aberration test) with 4-MBC were negative. Endocrine disruption: 4-MBC interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	SCCP, 2008b Schiffer et al., 2014

Endocrine disruption

4-MBC is on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) and on the SIN list (SIN list database, 2014). In 2012, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Hass et al., 2012). Based on this evaluation, the substance can be considered a suspected endocrine disruptor with a concern for both human health and the environment. Under REACH, a Risk Managemenet Option Analysis is currently under development, with an initial concern for endocrine disruptive effects. Whether this will lead to a need for futher evaluation of the substance or a proposal to identify the substance as an endocrine disruptor under REACH remains to be seen.

5.3.5 2-Ethylhexyl 4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)

No harmonised classification. Most notifiers have classified the substance Eye Irrit. 2 (269 out of 412). A smaller number have included Skin Irrit. 2 (83/412), STOT SE 3 (H335) (76/412) or STOT RE 3 (H373) (34/412) in the suggested classification (ECHA, 2014B). The substance is pre-registered under REACH.

OD-PABA is used as a UV-filter in cosmetics and as a photoinitiator in inks applied to food packaging materials. It is a tertiary amine derivative of p-aminobenzoic acid (PABA) (Kenney et al., 2005). OD-PABA is a yellow liquid that is virtually insoluble in water, but is freely soluble in many organic solvents (EFSA, 2005).

Two articles published in scientific magazines, as well as an EFSA opinion have been available to provide basic health data. Two articles were concerned with the toxicokinetics of OD-PABA. Kenney

et al. (2005) studied dermal absorption of the substance in hairless guinea pig skin and found substantial absorption rates of 42.5 and 11.6% using an ethanol and a lotion vehicle, respectively. With respect to the risk assessment, absorption of a lotion appears more relevant, why the value of 11.6% is chosen. León et al. (2010) studied biotransformation of the substance and developed methods for quantifying OD-PABA and metabolites. The authors identified two phase 1 metabolites, N,N-dimethyl-p-aminobenzoic acid (DMP, same as DMABA) and N-monomethyl-p-aminobenzoic acid (MMP), which are similar to the structure of PABA. However, phase 2 metabolism (acetylation and glucuronidation) differed from biotransformation of PABA (León et al., 2010). This impedes the validity of a read-across approach between OD-PABA and the well-investigated substance PABA.

The EFSA panel concluded that OD-PABA shows low acute toxicity. The EFSA opinion summarises the results of a 28-day oral toxicity study, a teratogenic gavage study in rats as well as a standard Ames test, chromosomal aberration tests and in a micronucleus test with the substance. The original studies have not been available. Spleen pigmentation was observed in females in the 28-day oral study. No evidence of teratogenic potential was observed. No evidence of genotoxicity was observed *in vitro* in the standard Ames, chromosomal aberration tests or in the micronucleus test in mouse bone marrow following administration of OD-PABA by intraperitoneal injection. Tests for photo-mutagenicity in bacteria and in mammalian cells *in vitro* gave negative results (EFSA, 2005).

A NOAEL of 100 mg/kg bw/day established by EFSA based on evidence of pigmentation of the spleen in females in a 28-day oral toxicity study will be used for the MOS calculation.

TABLE 48
HEALTH PROPERTIES OF 2-ETHYLHEXYL 4-(DIMETHYLAMINO)BENZOATE (OD PABA) (CAS NO. 21245-02-3)

Endpoint	Description	Reference
2-Ethylhexyl 4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3)		
Toxicokinetics	The *in vitro* percutaneous absorption and metabolism of OD-PABA was determined in hairless guinea pig skin. Absorption of OD-PABA was measured from a lotion and an ethanol vehicle. OD-PABA was applied to skin in 15 µL vehicle/cm² at a chemical dose of 6.7 µg/cm². Absorption from the lotion appeared to reach a steady state at 6 h; absorption from the ethanol vehicle appeared to reach a steady state at 12 h. Overall absorption of OD-PABA in viable skin was four times greater in the ethanol vehicle (42.5%) than that in the lotion vehicle (11.6%). Substantial amounts of the absorbed compound were hydrolysed to dimethyl aminobenzoic acid (DMABA) by esterase enzymes in skin.	Kenney et al., 1995
	The study investigated *in vitro* metabolism in rat liver microsomes. Two fase 1 metabolites, N,N-dimethyl-p-aminobenzoic acid (DMP, same as DMABA) and N-monomethyl-p-aminobenzoic acid (MMP) were identified. Secondly, the phase II metabolism was investigated. The investigated reactions were acetylation and glucuronidation working with rat liver cytosol and with both human and rat liver microsomes, respectively. Acetylated or glucuronidated conjugates could not be detected in the case of OD-PABA in contrast to conjugates of PABA. This leads to the conclusion that OD-PABA basically undergoes phase I metabolism.	León et al., 2010
Acute toxicity	No data	
Irritation and	No data	

Endpoint	Description	Reference
corrosivity		
Skin sensitisation	No data	
Subchronic/ repeated dose toxicity	OD-PABA was tested in a 28-day oral toxicity study in rat at the doses of 100, 300 and 1000 mg/kg bw. Moderate or moderately severe testicular atrophy was observed at the highest dose; spleen pigmentation was observed both in males (at 1000 mg/kg) and females (at 300 and 1000 mg/kg); spleen weight was increased in females (at 1000 mg/kg) and liver weight both in males (at 1000 mg/kg) and in females (at 300 and 1000 mg/kg). Based on the evidence of pigmentation of the spleen in females, a NOAEL of 100 mg/kg bw/day was established. No information on guidelines or GLP.	EFSA, 2005
Mutagenicity/ genotoxicity	No evidence of genotoxicity *in vitro* in the standard Ames, chromosomal aberration tests or in the micronucleus test in mouse bone marrow following administration of OD-PABA by intraperitoneal injection. Tests for photo-mutagenicity in bacteria and in mammalian cells *in vitro* gave negative results (no information on the original study available).	EFSA, 2005
Carcinogenicity	No data	
Reproductive toxicity	No evidence of teratogenic potential (no information on the original study available).	EFSA, 2005
Other effects	OD-PABA interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	Schiffer et al., 2014

Endocrine disruption

OD-PABA is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.6 Titanium dioxide (CAS No. 13463-67-7)

The substance has no harmonised classification. Most notifiers have suggested that the substance should no be classified (2579 out of 2978). 75 notifiers suggest Acute Tox. 4 (H332) and 72 suggest Carc. 2 (H351), and 32 suggest Eye Irrit. 2 (H319), 75 notified STOT SE 3 (H335) and 68 notified STOT RE 1 (H372). The substance is notified under REACH.

The summary is solely based on the SCCNFP (2000) (micro-crystalline) and SCCS (2014) (nano) opinions.

Titanium dioxide used in sunscreen products is reported to be composed of two crystalline types: rutile and anatase or a mixture of the two (SCCS, 2014).

Micro-crystalline titanium dioxide

The crystals of titanium dioxide are covered with various coating materials, which may be inorganic or organic; in these forms they are proposed for use in sunscreen formulations (SCCNFP, 2000).

Both titanium dioxide itself (in micro-crystalline form in most experiments), and various coated and doped preparations of micro-crystalline titanium dioxide, have been used in experiments (SCCNFP 2000) and results are summarised in the table below.

The toxicological profile of titanium dioxide does not give rise to concern in human use, since the substance is not absorbed through the skin. In view, also, of the lack of percutaneous absorption, a calculation of the MOS has not been carried out (SCCNFP, 2000).

The authors of this report agree with the evaluation of the SCCNFP.

Nano-form titanium dioxide
The different materials included in the dossier have been reported to be needle, spherical, or lanceolate (longer than wide) in shape. The primary particle size of the titanium dioxide nanomaterials has been reported to range from around 20 to 100 nm.

As a general consideration it is mentioned in the SCCS opinion that the submission consisted of 15 titanium dioxide nanomaterials that varied in terms of various physicochemical parameters (SCCS, 2014). Based on physicochemical considerations, the SCCS considered the titanium dioxide nanomaterials in the 3 groups for the purpose of the assessment: group 1) Nine materials on the basis that they are (mainly) rutile with a relatively low photocatalytic activity; group 2) three materials on the basis that they are rutile with a moderate photocatalytic activity; and group 3) three materials on the basis that they are (mainly) anatase, and also that they have a strong photocatalytic activity.

As another general consideration, it is mentioned in the SCCS opinion that the submitted studies ranged from old to recent ones (SCCS, 2014). A major proportion of the (old) studies were on materials for which little or no information on characterisation have been provided, which made it difficult to relate many of them to the nanomaterials under assessment in the opinion. The evaluation of these and other submitted studies showed that many of them were not relevant to the nanomaterials in the submission. Therefore, the relevance and usefulness of the data provided for the evaluation was poor and patchy. It was difficult (in some cases impossible) to relate the studies to the types of nanomaterials under evaluation. It would have been more productive if a complete set of supporting data was provided on one (or a few) rather than several different titanium dioxide nanomaterials in a single submission.

The main consideration in the SCCS assessment is the apparent lack of penetration of titanium dioxide nanoparticles through skin, which is supported by a body of evidence both in the form of the submitted studies and other studies reported in open literature (SCCS, 2014). In the absence of a systemic exposure, a MOS could not be calculated for titanium dioxide nanomaterials. From the limited relevant information submitted, and the information from open literature, the SCCS considered that titanium dioxide nanomaterials in a sunscreen formulation are unlikely to lead to: 1) systemic exposure to nanoparticles through human skin to reach viable cells of the epidermis, dermis, or other organs; 2) acute toxicity via dermal application or incidental oral ingestion; this, however, does not apply to sprayable applications that may lead to inhalation exposure of titanium dioxide nanomaterials, which may result in lung inflammation; 3) skin irritation, eye irritation, or skin sensitisation when (repeatedly) applied on healthy skin (except possible photoxicity of insufficiently coated nanomaterials); and 4) reproductive effects when applied on healthy skin.

Some titanium dioxide nanoparticles have been shown to be able to damage DNA and should be considered genotoxic. However, as negative results have also been reported, the current evidence in

relation to potential genotoxicity of titanium dioxide nanomaterials is not conclusive. Titanium dioxide particles have also shown to lead to carcinogenic effects after inhalation. These manifestations are a major hazard concern. However, no penetration was found through the stratum corneum of reconstructed human full thickness skin models and no DNA damage was detected by the Comet assay in these cells in contrast to epidermal cell line. Considering the absence of a systemic exposure, the SCCS considers that the use of nano titanium dioxide in dermally applied cosmetic products should not pose any significant risk to the consumer.

Evidence on acute and sub-chronic inhalation toxicity does not support the overall safety of use of titanium dioxide nanomaterial formulations for spray applications. In addition, tumour promoter activity of nano (non-coated) titanium dioxide has been shown after intra-pulmonary spraying. Therefore, the SCCS does not recommend the use of nano titanium dioxide in sprayable applications. This may be reconsidered if further evidence is provided to rule out the possibility that the nanoparticles can reach the lower respiratory tract during spray applications.

Although there is no conclusive evidence at present to indicate penetration of titanium dioxide nanoparticles through the skin to viable cells of the epidermis, a number of studies have shown that they can penetrate into the outer layers of the stratum corneum, and can also enter hair follicles and sweat glands. It is therefore recommended not to use titanium dioxide with substantially high photocatalytic activity in sunscreen formulations. Other titanium dioxide nanomaterials that have a relatively lower but still significant level of photocatalytic activity may be used, but further investigations over longer post-application periods taking into account the potential photocatalytic activity post-application, whilst allowing for appropriate lag-time and using realistic application scenarios may be necessary to ascertain that they do not pose a risk due to photocatalytic activity.

The authors of this report agree with the evaluation of the SCCNS.

TABLE 49
HEALTH PROPERTIES OF TITANIUM DIOXIDE (CAS NO. 13463-67-7)

Endpoint	Description	Reference
Titanium Dioxide (CAS No. 13463-67-7)		
Toxicokinetics	Micro-crystalline: Extensive tests for percutaneous absorption, mostly *in vitro*, indicate that absorption does not occur, either with coated or uncoated material; one experiment found some evidence that a little of the material could be found in the openings of the follicles. Nano-form: Two studies have been submitted on toxicokinetics of titanium dioxide following intravenous injection in rats and mice. In addition, there are few other relevant studies in the open literature relating to inhalation and intravenous, as well as limited (questionable) information on oral administration routes. The available evidence suggests that, if titanium dioxide particles become systemically available by the oral and inhalation uptake pathway, they are likely to accumulate mainly in the liver, followed by a very slow rate of clearance. A number of *in vitro* and *in vivo* dermal penetration studies have been submitted. In addition, there is a body of open literature on this subject. The evidence from these studies supports the conclusion that titanium dioxide nanoparticles are unlikely to penetrate across the skin to reach viable cells of the epidermis. In these studies, titanium dioxide nanoparticles have been shown to penetrate only to the outer layers of the stratum corneum, and there is as yet no	SCCNFP, 2000 SCCS, 2014

Endpoint	Description	Reference
	conclusive evidence to show that they do reach living cells of the epidermis/dermis. Studies have also shown that titanium dioxide nanoparticles do not penetrate the (simulated) sunburnt skin. Despite the extensive database showing a general lack of titanium dioxide nanoparticle absorption via the dermal route, there are a few gaps in the knowledge. For example, it is not clear whether titanium dioxide nanoparticles will be able to penetrate through cuts and bruises, or over repeated or long-term applications of a sunscreen formulation. A number of studies have indicated that titanium dioxide nanoparticle can enter the hair follicles and sweat glands, and that they may remain there for a number of days. This is a scenario in which titanium dioxide nanoparticles are likely to get and remain in a close proximity to the living cells for a length of time. A photocatalytic nanoparticle in such a situation may cause generation of reactive oxyradical species (ROS) and potential harmful effects when exposed to sunlight. More data would be needed to justify the use of those titanium dioxide nanoparticles in skin applications that have a considerable level of photocatalytic activity.	
Acute toxicity	Micro-crystalline: Acute oral toxicity is very low, both in coated and uncoated material. Acute dermal toxicity is also low, but in this case uncoated material was used. Nano-form: The submitted studies on acute oral toxicity mainly related to titanium dioxide nanomaterials that are anatase/rutile mixtures, coated with trimethoxy-n-octyl-silane. The submitted studies on acute dermal toxicity related to an ultrafine titanium dioxide material and a material described as 'natural colour', and were therefore of no relevance to the assessment of nanomaterials. No study has been submitted on acute inhalation toxicity. The limited relevant information submitted, and other information in the open literature, indicates that titanium dioxide nanomaterials are likely to be non-toxic via oral or dermal application routes.	SCCNFP, 2000 SCCS, 2014
Irritation and corrosivity	Micro-crystalline: Irritation of the skin is low or absent, both in animals and human subjects, using both coated and uncoated material. Irritation of mucous membranes is low or absent, both with coated and uncoated material; in one experiment in the rabbit, the uncoated material was judged to be moderately irritant. Titanium dioxide did not show a photo-irritation potential. Nano-form: Only two of the submitted studies were relevant to the titanium dioxide nanomaterials. They related to anatase/rutile mixtures, coated with trimethoxy-n-octyl-silane. The results showed primary irritation index between zero and 0.3. Two studies using ultrafine grade materials showed the mean irritation scores of 0.3 and 1.58-1.92 during 5 days repeat applications on rabbit skin. Other studies also showed the tested materials to be either mild- or non-irritant to rabbit and guinea pig skin, but it was not clear whether the tested materials were nanomaterials. From the limited relevant information submitted, it was considered that titanium dioxide nanomaterials are	SCCNFP, 2000 SCCS, 2014

Endpoint	Description	Reference
	likely to be mildly irritant or non-irritant to skin. Two studies tested titanium dioxide anatase/rutile mixtures, coated with trimethoxy-n-octyl-silane. From the studies, the derived primary irritation index was between zero and 0.3. A different study used ultrafine rutile material coated with alumina/silica and regarded the tested material as slightly irritant to rabbit eye. Another study found the tested titanium dioxide materials to be moderately irritant to rabbbit eye, but it is not clear whether the material was a nanomaterial. From the limited relevant data submitted, the eye irritation potential of titanium dioxide nanomaterials appears to be low.	
Skin sensitisation	Micro-crystalline: Sensitisation in animals and man was not found, using either coated or uncoated material. Titanium dioxide did not show a photo-sensitisation potential. Titanium dioxide did not induce a response indicative of a photo-allergic reaction in human volunteers. Nano-form: Two of the submitted studies have regarded titanium dioxide nanomaterials (anatase/ rutile mixture, coated with trimethoxy-caprylylsilane or trimethoxy-n-octyl-silane) as non-sensitiser. Another ultrafine material (rutile, coated with alumina/silica) is classified as a weak sensitiser, but characterisation data (particle size distribution) has not been reported to indicate what proportion of the particles was in the nano-scale. Due to the absence of skin penetration of titanium dioxide as demonstrated by many studies included in this dossier, the usefulness of the Buehler test for assessing sensitisation potency of nanomaterials is doubtful as it is based on exposure to intact skin. From the limited relevant data submitted titanium dioxide nanomaterials appear to be non- or weak skin sensitisers.	SCCNFP, 2000 SCCS, 2014
Subchronic/ repeated dose toxicity	Micro-crystalline: Titanium dioxide (anatase, uncoated) was administered in the diet to groups of 10 male and 10 female F334 rats and to 10 male and 10 female B6C3FI mice for 13 weeks. The dose levels were 0, 6,250, 12,500, 25,000, 50,000, and 100,000 ppm. There were no deaths; body weights were not affected, and no gross or microscopic pathological changes were found which could be attributed to the test compound. Nano-form: Only two of the four submitted subchronic studies on repeated dose toxicity are relevant to the titanium dioxide nanomaterials under evaluation in the SCCS opinion. From these studies which related to oral exposure, a LOAEL of 5 mg/kg bw/day has been derived. Studies in open literature indicate that subacute repeated dose respiratory toxicity studies with nano size titanium dioxide induce an acute inflammation in the lungs that may be reversible depending on the dose and the time evaluated after exposure. In view of this, acute inflammation (spray) applications, which may result in inhalation exposure is not recommended by the SCCS.	SCCNFP, 2000 SCCS, 2014

Endpoint	Description	Reference
Mutagenicity/ genotoxicity	Micro-crystalline: Numerous tests for mutagenicity and clastogenicity have been carried out, and consistently show negative results. Nano-form: Although an extensive range of studies on mutagenicity has been submitted, most of them have not been conducted in any special consideration of the nano-related properties of the test materials. Several studies have been performed mainly to investigate mechanistic effects relating to DNA damage and genotoxic properties. These studies are usually not performed according to specific genotoxicity guidelines (e.g. OECD). Many of the studies have not evaluated the effects in a dose- and/or time- dependent manner. Those that have addressed this, often reveal no clear dose- or time- dependent effects. From the submitted studies, and open literature, titanium dioxide particles have also been reported, or suggested, to interfere with the assays. Overall, in a number of assays, titanium dioxide nano particles were observed to induce DNA damage, so titanium dioxide nano particles have to be considered genotoxic. It is also of note that appropriate coating of nanomaterial to quench surface photocatalytic activity will also reduce the likelihood of generation of reactive oxygen species (ROS), which may in turn reduce the chances of genotoxicity.	SCCNFP, 2000 SCCS, 2014
Carcinogenicity	Micro-crystalline: Long term feeding studies in rat and mouse with uncoated pigmentary material showed no evidence of carcinogenesis. It is mentioned in the SCCNFP opinion that Colipa had obtained the values for the distribution of particle size of the titanium dioxide used in these experiments, and reported that about 10% of the material had a small crystal diameter. Thus the NOAEL found in these experiments could be calculated to give a value of one-tenth if present day small crystal material had been used - about 375 and 750 mg/kg bw/day in rats and mice respectively. Rats were exposed to 10, 50 and 250 mg/m^3 of titanium dioxide dust (uncoated) for 24 months. In the top dose animals squamous cell carcinomas appeared. Inhalation studies in rats, and epidemiological evidence in man, using uncoated finely divided material, suggest that it causes an increase in the incidence of lung tumours. This, however, probably reflects the actions of irritating dusts generally. Nano-form: Pigmentary and ultrafine titanium dioxide materials have been tested for carcinogenicity by oral administration in mice and rats, by inhalation exposure in rats and female mice, by intratracheal administration in hamsters and female rats and mice, and by subcutaneous injection in rats and by intraperitoneal administration in male mice and female rats. According to the evaluation of titanium dioxide by IARC (2010), induction of lung tumours was observed in two inhalation studies with rats. Two other inhalation studies in rats, and one in female mice gave negative results. Intratracheally instilled female rats showed an increased incidence of lung tumours following treatment with two types of titanium dioxide. Tumour incidence was not increased in intratracheally instilled hamsters and female mice.	SCCNFP, 2000 SCCS, 2014

Endpoint	Description	Reference
	Oral, subcutaneous and intraperitoneal administration did not produce a significant increase in the frequency of any type of tumour in mice or rats. IARC concluded that there is inadequate evidence in humans for the carcinogenicity of titanium dioxide but sufficient evidence in experimental animals for the carcinogenicity of titanium dioxide. Both nano and non-nano size titanium dioxide was classified as a Group 2B carcinogen (Possibly carcinogenic to humans). One, two-stage rat lung carcinogenicity study carried out with non-coated (nc) titanium dioxide in rats 'initiated' by DHPN (N-nitrosobis(2-hydroxypropyl)amine) in the drinking water prior to intra-pulmonary spraying with non-coated titanium dioxide demonstrated promoter activity of non-coated titanium dioxide. Since titanium dioxide particles have shown carcinogenic activity (after inhalation) and since nano non-coated titanium dioxide showed promoter activity after intra-pulmonary spraying, the use of nano titanium dioxide in sprayable applications is not recommended by the SCCS.	
Reproductive toxicity	Micro-crystalline: No data. Nano-form: No study has been submitted on reproductive toxicity that is relevant to the nanomaterials under assessment. A review article covered exploratory studies in mice, which related to the use of a titanium dioxide material which is <10 µm (with no further information), and a titanium dioxide nanomaterial with primary particle size 25-70 nm (no further information). Other studies in open literature have indicated the possibility of placental transport in pregnant animals into the foetus, or found effects in the offspring for various manufactured nanomaterials including nano titanium dioxide. However, the information relating to this endpoint is patchy and therefore inconclusive.	SCCNFP, 2000 SCCS, 2014
Other effects	Micro-crystalline: Titanium dioxide did not show photo-toxic activity in studies *in vivo* or *in vitro*. Titanium dioxide is photocatalytic in ultraviolet light, but the relevance of this is doubtful in the absence of dermal penetration, as well as the fact that the coated preparations show much less photo-catalytic activity than the uncoated material. Nano-form: Only a few studies have been submitted that are relevant to the nanomaterials under assessment. These indicate that titanium dioxide materials may not be photo-sensitisers. Several studies have specifically addressed photo-sensitization effects titanium dioxide. However, the outcomes of these studies need to differentiate between photo-sensitization and other local effects on skin (taking into account the aspect of penetration), versus potential effects at other target sites. Among the nanomaterials assessed, the SCCS noted a potential concern in relation to photocatalytic activity, and stability of the coating, of some of the materials. This is an important aspect to ascertain because application of a formulation containing a nanomaterial that has a significant photocatalytic activity may lead	SCCNFP, 2000 SCCS, 2014

Endpoint	Description	Reference
	to local effects on sun-exposed skin. Such effects may or may not manifest during the immediate use, and it is important to investigate the possibility of latent effects following the use of a skin product that contained photocatalytic nanoparticles. This is because, whilst most studies on dermal absorption indicate that titanium dioxide nanoparticles are not able to penetrate the skin deep enough to reach live cells of the epidermis/dermis, they do show that nanoparticles can penetrate into stratum corneum, and can also enter hair follicles and sweat glands. It is therefore possible that a trace amount of nanoparticles may remain embedded in stratum corneum, in hair follicles, and/or sweat glands, potentially over several days after skin application of a product and washing off. If the nanoparticles have a significant photocatalytic activity, there is a possibility that they may cause generation of reactive radical species on exposure to sunlight, long after the skin formulation had been applied and washed off. This, in a close proximity of living cells, raises a concern over the possibility of harmful effects. The titanium dioxide nanomaterials in the current submission that have a high photocatalytic activity include anatase materials in non-coated and coated forms. Three other rutile coated nanomaterials also have comparatively lower but still significant levels of photocatalytic activity. The SCCS considers up to 10% photocatalytic activity compared to corresponding non-coated or non-doped reference as acceptable. In view of this, the SCCS did not recommend the use of nanomaterials that have a high photocatalytic activity in dermal formulations. These eight materials can only be recommended after appropriate coating/doping has been applied to quench their photocatalytic activity down to acceptable levels. Three rutile materials with relatively lower but still significant levels of photocatalytic activity may be used in dermal formulations, but further investigations over longer post-application periods may be necessary to ascertain that they do not pose a risk due to photocatalytic activity.	

Endocrine disruption

Titanium dioxide is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not. Under REACH the substance is on the CoRAP list and currently undergoing substance evaluation (started in 2014), but the initial concern is not endocrine disruptive effects. If a concern for endocrine disruptive effects arise when data are evaluated, it can lead to a request for more data to clarify this concern. This is expected to be resolved in 2016.

5.3.7 Butyl methoxydibenzoylmethane (BMDBM) (CAS No. 70356-09-1)

No harmonised classifications. 1215 out of 1216 notifiers have only suggested an environmental classification of the substance (ECHA, 2014B). The substance is registered under REACH.

The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

According to the registration dossier (ECHA, 2014A), BMDBM shows a very low percutaneous absorption in humans. In an *in vitro* dermal absorption study with human skin (2% BMDBM in water-oil cream) dermal absorption increased with exposure time from 0.3% (1h) over 0.7% (6h) to 10.14% (18h) with the majority penetrating into the upper part of the dermis (ECHA, 2014A). In an *in vitro* dermal absorption study with pig skin (2 or 7.5% BMDBM in oil-water lotion, oil-water cream or water-oil cream) almost the whole part (= 95%) remained on the skin surface. 1.0-1.7% were adsorbed on the stratum corneum, 0.9-3.4% absorbed in the skin and only a minimum (<=0.5%) was found to pass the skin. Skin absorption/penetration was not affected by the different vehicles (ECHA, 2014A). The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of BMDBM in sunscreens and other cosmetic formulations.

According to the registration dossier (ECHA, 2014A) BMDBM is of low acute toxicity, very slightly irritating to the skin, not irritating to the eyes, not a skin sensitiser, and does not possess mutagenic or genotoxic properties.

In a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 450 mg/kg bw/day was concluded (ECHA, 2014A). In a subacute dermal repeated dose toxicity studies performed in rabbits, the NOAEL for systemic toxicity was set to the highest applied dose of 360 mg/kg bw/day and the NOAEL for local toxicity was set at 100 mg/kg bw/day (ECHA, 2014A). In a teratogenicity study in rat a NOAEL for maternal, developmental and embryotoxicity of 1,000 mg/kg bw/day was concluded (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 450 mg/kg bw/day will be used for the preliminary MOS calculation.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

TABLE 50
HEALTH PROPERTIES OF BUTYL METHOXYDIBENZOYLMETHANE (BMDBM) (CAS NO. 70356-09-1)

Endpoint	Description	Reference
Butyl methoxydibenzoylmethane (BMDBM) (CAS No. 70356-09-1)		
Toxicokinetics	25 µCi ^{14}C-BMDBM (10%) was dermally applied to 3 human volunteers for 8 hours. Recovery was measured in skin (by analysing Q-tips and tape strippings used after end of application), urine, blood and faeces up to 120 hours after application. Recoveries were 0.08 - 0.28% and 0.012 – 0.016% in skin (stripping) and urine, respectively. ^{14}C-BMDBM was not recovered in plasma or faeces. It was concluded that BMDBM shows a very low percutaneous absorption that is indicated by high recovery of the dose from the skin, undetectable radioactivity in plasma and faeces and a very low percentage of applied dose excreted in the urine. An *in vitro* absorption study was carried out on human cadaver abdominal skin with a 2% solution (water-oil cream). Distribution (% of the applied dose) after 1, 6 and 18 hours was 4.23, 6.37 and 5.92 (horny layer); 0.08, 0.29 and 2.74 (epidermis); 0.18, 0.37 and 6.96 (upper corium); 0.02, 0 and 0.34 (lower corium) and 0, 0 and 0.1 (subcutaneous fat), respectively. After dermal application of the test substance BMDBM as 2% formulation in W/O cream, no accumulation in the penetration chamber water was measured. Dermal absorption increased with exposure time from 0.3% (1h) over 0.7% (6h) to 10.14% (18h) with the majority penetrating into the upper part of the dermis. In an *in vitro* absorption study (equivalent or similar to OECD TG 428) excised skin samples from mini pigs were exposed to 2 or 7.5%	ECHA, 2014A

Endpoint	Description	Reference
	solutions in oil-water lotion, oil-water cream or water-oil cream for 6 hours. Distribution (% of the applied dose) after 2% in oil-water lotion, oil-water cream and water-oil cream was 1.7, 1.5 and 1.4 (horny layer); 0.9, 1.2 and 1.5 (epidermis) and 0, 0 and 0 (chamber liquid), respectively. Distribution (% of the applied dose) after 7.5% in oil-water lotion, oil-water cream and water-oil cream was 1.1, 1 and 1.2 (horny layer); 2.4, 3.1 and 3.4 (epidermis) and 0.4, 0.4 and 0.5 (chamber liquid), respectively. Results showed that almost the whole part of topically applied BMDBM (= 95%) remained on the skin surface. 1.0-1.7% were adsorbed on the stratum corneum, 0.9-3.4% absorbed in the skin and only a minimum (<=0.5%) was found to pass the skin. Skin absorption/penetration was not affected by the different vehicles.	
Acute toxicity	Acute oral LD50 > 16,000 mg/kg bw for rats (performed similar to OECD TG 401). Acute dermal LD50 > 1,000 mg/kg bw for rats (performed similar to OECD TG 402).	ECHA, 2014A
Irritation and corrosivity	In an *in vivo* study on dermal irritation (performed equivalent or similar to OECD TG 404), New Zealand White rabbits (6 animals/group) were exposed to 0 or 10% BMDBM (vehicle: ethanol/2-phenylethanol (50/50)) for 4 hours (intact or abraded skin). No to slight erythema and oedema (scores 1 and 2) was observed in the treated animals. Also the vehicle ethanol/2-phenylethanol (50/50) caused these effects but in a somewhat lower potency (score 1). It can therefore be concluded that the skin irritations are mainly due to the vehicle used and that BMDBM bears very slight irritating potential. Deviations from OECD TG 404 included: occlusive instead of semi-occlusive dressing, scoring after 4 instead of 1 hour after application. In an *in vivo* study on eye irritation (performed equivalent or similar to OECD TG 405), New Zealand White rabbits (3 animals/group) were exposed to 5, 10 or 20% (in diethylphtalate). The instillation of a solution of BMDBM caused concentration-dependent weak conjunctival irritation of the rabbit eye which was fully reversible within up to 3 days. The mean irritation scores for the 5, 10 and 20% were 0, 0.44 and 0.67, respectively, for conjunctival redness. No other irritation parameters were affected. BMDBM can be considered as non-irritant to the eye. Deviations from OECD TG 405 included: the test item was dissolved in diethylphtalate, concentration: 5-20%. In an *in vivo* study on eye irritation (OECD TG 405), conjunctival redness (score 1) was observed at 1 and 24 hours after instillation of 3% BMDBM (in sunscreen) in the left eye of New Zealand White rabbits (3 animals). The test item was considered as non-irritant to the eye. Deviations from OECD TG 405 includes: a 3% solution of BMDM in sunscreen was used as test item and not BMDM as such.	ECHA, 2014A
Skin sensitisation	No sensitization reactions were observed in an *in vivo* guinea pig maximization test (performed equivalent or similar to OECD TG 406). Deviations from OECD TG 406 included: no grading but only sensitisation-positive animals were reported.	ECHA, 2014A
Sub-chronic/	In an oral sub-chronic study (performed equivalent or similar to	ECHA, 2014A

Endpoint	Description	Reference
repeated dose toxicity	OECD TG 408), Füllinsdorf Albino-SPF rats (12 animals/sex/group) were given 0, 200, 450 or 1000 mg/kg bw/day in the diet for 91-94 days. Effects on haematology, clinical chemistry, organ weights and non-neoplastic histopathology were seen in the high dose group. A NOAEL and LOAEL (significantly increased absolute and relative liver weights and a decrease in Hb and RBC in females) of 450 and 1000 mg/kg bw/day, respectively, were concluded. Deviations from OECD TG 408 included: lack of neurobehavioral tests and purity of the test item; inclusion of a 4-week recovery period in the control and high-dose group. In a dermal sub-acute study (performed equivalent or similar to OECD TG 410), New Zealand White rabbits (10 animals/sex/group) were applied 0, 30, 100 or 360 mg/kg bw/day to intact or abraded skin for 21 days (6 hours/day). The NOAEL for systemic toxicity was set to the highest applied dose of 360 mg/kg bw/day. There was a dosage-related increase in the severity of dermal reactions of rabbits treated with BMDBM, including slight to moderate erythema and oedema. The respective vehicle control exhibited only slight dermal reactions. The NOAEL for local toxicity was set at 100 mg/kg bw/day. Deviations from OECD TG 410 included: use of intact as well as abraded skin.	
Mutagenicity/ genotoxicity	BMDBM was negative in an *in vitro* bacterial reverse mutation assay performed (OECD TG 471) in *S. typhimurium* strains TA 1535, TA 1537, TA 1538, TA 98, TA 100 and TA 102 (with or without metabolic activation) at concentrations up to 5000 µg/plate. BMDBM was negative in an *in vitro* mammalian cell gene mutation assay (performed equivalent or similar to OECD TG 476) with Chinese hamster lung fibroblasts (V79) (with or without metabolic activation) at concentrations up to 20 µg/mL. BMDBM was negative in an *in vivo* micronucleus assay (performed equivalent or similar to OECD TG 474) in bone marrow derived polychromaticerytrocytes from mice (oral application 100, 2500 and 5000 mg/kg bw).	ECHA, 2014A
Carcinogenicity	No data	
Reproductive toxicity	In a developmental toxicity study (performed equivalent or similar to OECD TG 414), Füllinsdorf-Albino SPF rats (36 mated females/group) were given 0, 250, 500 or 1,000 mg/kg bw/day by gavage on day 6 to day 17 of gestation (12 days). No dose-related adverse effects were seen on any parameters and a NOAEL for maternal, developmental and embryotoxicity of 1,000 mg/kg bw/day was concluded. Deviations from OECD TG 414 included: administration on days 7-16 inclusive of gestation.	ECHA, 2014A
Other effects	No data.	

Endocrine disruption

Butyl methoxydibenzoylmethane is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall

conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.8 Ethylhexyl salicylate (CAS No. 118-60-5)

No harmonised classification. Most notifiers (878 out of 894) have suggested a classification as Skin Irrit. 2 (H315). 12 suggested no classification (ECHA, 2014B). The substance is registered under REACH.

The summary is based on the SCC (2000) opinion, the CIR review (CIR, 2003), one publication (Lapczynski et al., 2007), as well as data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

In *in vitro* dermal absorption studies with human skin the permeation of the test article is relatively low with an absorption of 0.65~1.14% of the applied dose (a finite/infinite dose of ethylhexyl salicylate in an oil-in-water emulsion/hydroalcoholic formulation vehicle at two different concentrations) (ECHA, 2014A). The SCC considered an overall percutaneous absorption of 0.5% (SCC, 2000). The authors of this report agree with the evaluation of the SCC; a dermal absorption of 0.5% will be used for the MOS calculation for use of ethylhexyl salicylate in sunscreens and other cosmetic formulations.

Ethylhexyl salicylate is of low acute toxicity (SCC, 2000; Lapczynski et al., 2007; CIR, 2003; ECHA, 2014A), slightly irritating to the skin (SCC, 2000; Lapczynski et al 2007; CIR, 2003; ECHA, 2014A), slightly irritating to the eyes (ECHA, 2014A), not a skin sensitiser (Lapczynski et al., 2007; CIR, 2003; ECHA, 2014A), not a photoallergen (SCC, 2000;) and does not possess mutagenic or genotoxic properties (SCC, 2000; CIR, 2003; ECHA, 2014A).

In a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 250 mg/kg bw/day or higher was considered (SCC, 2000; ECHA, 2014A). In a subchronic dermal repeated dose toxicity studies performed in rats, a NOAEL for systemic toxicity of 55.5 mg/kg bw/day was considered; the NOAEL for local toxicity was below 55.5 mg/kg bw/day (SCC, 2000).

In a reproduction / developmental toxicity screening study in rat the NOAEL of general systemic toxicity was considered to be 80 mg/kg bw/day, the NOEL of reproduction toxicity to be 25 mg/kg bw/day, and the NOEL for developmental toxicity to be 80 mg/kg bw/day (ECHA, 2014A).

Based on the subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 250 mg/kg bw/day can be considered (SCC, 2000). The authors of this report agree with the evaluation of the SCC; a NOAEL of 250 mg/kg bw/day will be used for the MOS calculation.

No adverse effects were seen for ethylhexyl salicylate (5%) in a test for phototoxicity when applied to human skin (SCC, 2000; CIR, 2003).

TABLE 51
HEALTH PROPERTIES OF ETHYLHEXYL SALICYLATE (CAS NO. 118-60-5)

Endpoint	Description	Reference
Ethylhexyl salicylate (CAS No. 118-60-5)		
Toxicokinetics	In four human volunteers the stratum corneum levels of 3% ethylhexyl salicylate (in petrolatum or an oil-water emulsion-gel) after 30 min were 40-50% and 10-15% of the applied dose after emulsion-gel and petrolatum, respectively.	Lapczynski et al., 2007; CIR,2003

Endpoint	Description	Reference
	The *in vitro* penetration of 3% ethylhexyl salicylate (emulsion-gel (2.26±0.21 mg/cm²) or petrolatum (2.52±0.4 mg/cm²)) was evaluated in human skin samples (600 µm) after 2 min, 0.5, 2 and 6 hours (method equivalent or similar to OECD TG 428). Ethylhexyl salicylate was recovered in the epidermis (both solvents) at all applications. The maximum recovery was obtained after 6 hours with 7.29±1.8% and 1.96±0.2% of the applied dose in the epidermis when applied in the emulsion-gel and petrolatum, respectively, and 0.51 ±0.7% was found in the dermis (emulsion-gel only). No recoveries were made in the receptor fluid. According to the Registration dossier it was concluded that very little 2-ethylhexyl salicylate was found in the epidermis and none to very little of the dose was recovered from the dermis at any time. No ethylhexyl salicylate was detected in the receptor fluid. Thus, 2-ethylhexyl salicylate did not penetrate skin and systemic absorption in the dermis is considered also to be very low.	Lapczynski et al., 2007; CIR,2003; ECHA, 2014A
	The *in vitro* skin absorption of ethylhexyl salicylate was tested by a method equivalent or similar to OECD TG 428 using human abdominal skin. Ethylhexyl salicylate was applied in an oil-water emulsion or a hydroalcoholic formulation in a concentration of 5 or 100 µL/cm² for 48 hours (n=9-12). Total absorption was 0.65±0.16% and 0.47±0.22% after 5 and 100 µL/cm², respectively, when applied in the oil-water emulsion and 0.59±0.09% and 0.23±0.05% after 5 and 100 µL/cm², respectively, when applied in the hydroalcoholic formulation. According to the SCC opinion, an overall percutaneous absorption of 0.5% was considered. According to the Registration dossier it was concluded that the *in vitro* human skin permeation of test article is relatively low with an absorption of test article after application as a finite/infinite dose in an oil-in-water emulsion/hydroalcoholic formulation vehicle of 0.65~1.14% of the applied dose.	ECHA, 2014A; SCC, 2000
Acute toxicity	An oral LD50 of 4800 mg/kg bw was estimated in a range finding study in rats.	SCC, 2000
	Acute oral LD50 > 5000 mg/kg for rats.	Lapczynski et al., 2007; CIR, 2003
	Acute oral LD50 > 2000 mg/kg for rats (OECD TG 401).	CIR, 2003
	Acute dermal LD50 > 5000 mg/kg for rats	ECHA, 2014A
	Acute dermal LD50 > 5000 mg/kg for rabbits	Lapczynski et al., 2007; CIR, 2003
Irritation and corrosivity	Undiluted ethylhexyl salicylate applied to intact or abraded rabbit skin for 24 hours was mildly irritating.	Lapczynski et al., 2007; CIR, 2003
	A primary skin irritation study (OECD TG 404) in rabbits with undiluted (100%), 25, 5 or 1% solutions (vehicle: ethanol 96% and diethyl phthalate in the ratio 1:1 (w/w)) gave mean scores of 2.5, 1.7, 0.1 and 0.1 for erythema and 1.7, 0.9, 0 and 0 for oedema, respectively. According to the registration dossier, the test material was considered as a skin irritant to rabbits; however, the purity was not reported in the report and thus the finding is of limited value for assessing the pure substance.	CIR, 2003, ECHA, 2014A
	In a primary skin irritation study (OECD TG 404), New Zealand White rabbits (3 males) were exposed to 0.5 mL undiluted ethylhexyl	ECHA, 2014A

Endpoint	Description	Reference
	salicylate for 3 min, 1 hour and 4 hours. A well-defined erythema (grade 2) was noted 1 hour after removal of patches but reversed to grade 0 within 24 hours in 2 animals and within 48 hours in one animal; oedema was not recorded. Following 3 minutes exposure dryness of the skin was noted from day 4 up to day 13. The test item was considered to be slightly irritating when applied topically to rabbits.	
	Ethylhexyl salicylate (4%) was not irritating in a 48-hours occlusive patch test.	Lapczynski et al., 2007; CIR, 2003
	No reaction was observed when ethylhexyl salicylate (5% dilution) was applied to human skin under occlusion for 24 hours.	SCC, 2000
	No reaction was observed when ethylhexyl salicylate (possibly undiluted, but more probably a 5% formulation; the report is not clear) was repeatedly applied to human skin under occlusion for 48 hours.	SCC, 2000
	In an *in vivo* study on eye irritation (OECD TG 405), New Zealand White rabbits (3 females) were exposed to ethylhexyl salicylate (50% solution in diethyl phthalate). Slight reactions of conjunctiva (redness) were seen in one rabbit at the 1- and 24-hour reading. No reactions of the conjunctiva, iris or cornea were observed in any of the rabbits at the 48- and 72-hour readings. According to the Registration dossier, it can be concluded that test article in a 50% solution caused no eye irritation to rabbits.	CIR, 2003, ECHA, 2014A
	In an *in vivo* study on eye irritation (OECD TG 405), New Zealand White rabbits (3 animals) were exposed to undiluted ethylhexyl salicylate. A slight or moderate chemosis (grade 1 or 2) and a slight or moderate redness of the conjunctiva (grade 1 or 2) were observed in all animals on day 1. A slight chemosis was still observed on day 2 in 1/3 animals. Slight redness was noted until day 3 in 2/3 animals. No ocular reactions were observed on day 4. Mean scores calculated for each animal over 24, 48 and 72 hours were 0.3, 0.0 and 0.0 for chemosis, 0.7, 0.3 and 0.7 for redness of the conjunctiva, 0.0, 0.0 and 0.0 for iris lesions and 0.0, 0.0 and 0.0 for corneal opacity. The test item was slightly irritant when administered by ocular route to rabbits.	ECHA, 2014A
Skin sensitisation	Ethylhexyl salicylate was not a sensitizer in guinea pigs (OECD TG 406).	CIR, 2003, ECHA, 2014A
	No sensitization reactions were observed in a maximization test performed in 23 subjects (4% ethylhexyl salicylate).	Lapczynski et al., 2007; CIR, 2003
	No reactions were seen in a test for photocontact allergy in 25 human subjects when ethylhexyl salicylate (15%) was applied to skin for 24 hours.	SCC, 2000
Subchronic/ repeated dose toxicity	In an oral subchronic toxicity study (OECD TG 408) rats (10-20 animals/sex/group) were given dietary levels of 0, 50, 100 or 250 mg/kg bw/day for 13 weeks. No statistically significant dose-related effects were observed. According to the SCC the NOAEL might be greater than 250 mg/kg bw/day (highest dose level in the study). According to the registration dossier, the NOAEL for subchronic toxicity of test article is considered to be 250 mg/kg/day based on the results given in this study.	SCC, 2000; ECHA, 2014A
	In a dermal subcronic toxicity study, rats (40 animals/sex/group)	

Endpoint	Description	Reference
	were applied doses of 0, 55.5, 277 or 555 mg/kg bw/day to the shaved skin of the back, 5 days a week, for 13 weeks. Effects on body weight and body weight gain were observed in the 277 and 555 mg/kg bw/day dose groups. Skin irritation and hyperkeratosis were observed in all dosed animals in a dose-related manner. A NOAEL of 55.5 mg/kg bw/day was considered for systemic toxicity. The NOAEL for local toxicity is below 55.5 mg/kg bw/day.	SCC, 2000
	In the reproduction / developmental screening study (OECD TG 421) described below effects were seen on mortality, body weight and food consumption in the parental generation. Based on the results of this study, the NOAEL of general systemic toxicity is considered to be 80 mg/kg bw/day (unclear death of one female at 250 mg/kg bw/day).	ECHA, 2014A
Mutagenicity/ genotoxicity	Ethylhexyl salicylate was not mutagenic in a bacterial reverse mutation assay with *S. typhimurium* strains TA1535, TA1537, TA98 and TA100 at concentrations of 3,000 to 75,000 µg/plate (without metabolic activation) and 100 to 3,000 µg/plate (with metabolic activation).	CIR, 2003
	Ethylhexyl salicylate was negative in a bacterial reverse mutation assay (OECD TG 471) with *S. typhimurium* strains TA1535, TA1537, TA98, TA100 and TA102 at concentrations up to 5,000 µg/plate with and without activation.	ECHA, 2014A
	Ethylhexyl salicylate was negative in a bacterial reverse mutation assay (OECD TG 471) with *S. typhimurium* strains TA1535, TA1537, TA98, TA100 and TA1538 (with or without metabolic activation) at concentrations of 3 to 75 µL/plate (without activation) and 0.3 to 75 µL/plate (with activation).	ECHA, 2014A
	Ethylhexyl salicylate was negative in an *in vitro* mammalian chromosome aberration test carried out according to GLP in a culture of Chinese hamster ovary cells (with or without metabolic activation) at concentrations up to 100 µg/mL (with activation) and up to 20 µg/mL (without activation).	SCC, 2000
	Ethylhexyl salicylate was negative in an *in vitro* mammalian chromosome aberration test (OECD TG 473) in Chinese hamster ovary cells (with or without metabolic activation) at concentrations up to 5000 µg/mL.	ECHA, 2014A
	Ethylhexyl salicylate was negative in an *in vitro* mammalian cell gene mutation assay (OECD TG 476) with Chinese hamster lung fibroblasts (V79) at concentrations up to 20 µg/mL (without activation) and up to 640 µg/mL (with activation).	ECHA, 2014A
	Ethylhexyl salicylate did not increase micronucleated polychromatic erythrocytes up to 72 hours after dosing in an *in vivo* micronucleus test (OECD TG 474) performed in mice (oral application 2000 mg/kg).	CIR, 2003
Carcinogenicity	No data	
Reproductive toxicity	In a screening study (OECD TG 421) RccHanTM:WIST(SPF) rats (11 animals/sex/group) were given 0, 25, 80 or 250 mg/kg bw/day by gavage for 28 days (males) and 7 weeks (females). Effects were seen on mortality, body weight and food consumption in the parental generation and on viability and body weight in the offspring. Based on the results of this study, the NOAEL of general systemic toxicity is considered to be 80 mg/kg bw/day (unclear death of one female at	ECHA, 2014A

Endpoint	Description	Reference
	250 mg/kg bw/day), the NOEL of reproduction toxicity is considered to be 25 mg/kg bw/day (prolonged gestation, reduced gestation index and increased post-implantation loss resulting in lower litter size at the dose levels of 250 and 80 mg/kg bw/day), and the NOEL for developmental toxicity was set to 80 mg/kg bw/day (reduced absolute body weights of pups at the dose level of 250 mg/kg bw/day).	
Other effects	No adverse effects were seen for ethylhexyl salicylate (5%) in a test for phototoxicity when applied to human skin (10 subjects) and exposed to ultraviolet radiation (320 to 410 nm).	CIR, 2003; SCC, 2000

Endocrine disruption

Ethylhexyl Salicylate is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.9 Ethylhexyl triazone (CAS No. 88122-99-0)

Harmonised classification with hazard class Aquatic chronic 4. No notified classification relevant for human health (ECHA, 2014B). The substance is registered under REACH.

The summary is based on data available in the REACH registration dossier (ECHA, 2014A), as well as a study by Monti et al., 2008. It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

Data from the registration dossier documents that the dermal uptake of ethylhexyltriazone is negligible or low (maximum uptake of 1.3%) (ECHA, 2014A), which was confirmed in the study by Monti et al. (2008). Other toxicokinetics studies have not been available. The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of ethylhexyl triazone in sunscreens and other cosmetic formulations.

Ethylhexyl triazone is not skin-irritating. Data on eye-irritation show that possible effects on eye irritation with the undiluted substance are reversible. Several studies in the registration dossier document that the substance is neither genotoxic nor mutagenic. Carcinogenicity studies have not been available.

The substance has shown very low toxicity following oral exposure in both acute and repeated exposure studies with effect concentrations ranging from 1000 to >5000 mg/kg bw/day. The only available developmental study did not result in any adverse effects at the dose levels tested and a NOAEL of 1000 mg/kg bw/day was established by the registrant (ECHA 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 1000 mg/kg bw/day will be used for the preliminary MOS calculation.

TABLE 52
HEALTH PROPERTIES OF ETHYLHEXYL TRIAZONE (CAS NO. 88122-99-0)

Endpoint	Description	Reference
Ethylhexyl triazone (CAS No. 88122-99-0)		
Toxicokinetics	Penetration through human epidermis *in vitro* was tested with a 5% test substance in a sunscreening product formulation. Approx. 0.1% (= approx. 0.05 ug/cm²) at the high dose (10 mg of the preparation/cm²) and approx. 1.3% (= approx 0.065 ug/cm²) at the low dose (1 mg of the preparation/cm²) have penetrated the epidermis 24 hours after application.	ECHA, 2014A
	The aims of the study were to develop a simple and reproducible procedure for percutaneous absorption and distribution tests of sunscreens using one human skin culture model and compare the model with rat skin *in vitro*. The cutaneous permeation and distribution of ethylhexyltriazone using 3 different vehicles was investigated. The substance did not permeate through neither the human skin model nor rat skin. No information on GLP compliance or test guidelines.	Monti et al., 2008
Acute toxicity	A rat study after OECD TG 401 (Acute Oral Toxicity) revealed a LD50 > 5000 mg/kg bw. No mortality was observed at a dose of 5000 mg/kg.	ECHA, 2014A
Irritation and corrosivity	Rabbit, skin, according to OECD TG 404: Rabbits showed no signs of irritation after 24, 28 and 72 hours based on erythema scores (0 for all animals) and edema scores (0 for all animals). Rabbit, eye, according OECD TG 405: Study with 3 rabbits dosed once with 41 mg of undiluted substance. Conjunctivae score: One out of three animals showed redness (score 0.66, max. score 2), effects were fully reversible within 2 days. Chemosis score: None of the animals showed irritation at any time point. Cornea score: None of the animals showed irritation at any time point. Iris score: None of the animals showed irritation at any time point.	ECHA, 2014A
Skin sensitisation	A study with 20 guinea pigs following OECD TG 406 (Skin Sensitisation) showed no evidence of sensitisation.	ECHA, 2014A
Subchronic/ repeated dose toxicity	Rat, oral, 90 d, OECD TG 408 (Repeated Dose 90-Day Oral Toxicity in Rodents): Rats were exposed in groups of 10 animals/dose/sex with 0, 1000, 4000, and 16000 mg/kg bw/day. A NOAEL of ≤ 1275 mg/kg bw/day (nominal) was identified. Effects were not specified. Rat, oral, 90 d, OECD TG 408: NOEL 1000 mg/kg bw/day (nominal) Effect not specified.	ECHA, 2014A
Mutagenicity/ genotoxicity	Chinese hamster ovary cells were tested according to OECD TG 476, EU Method B.17, and EPA OTS 798.5300 with and without metabolic activation. The test system showed clearly cytotoxic effects, but no genotoxic effects. Chinese Hamster V79 cells were tested according to EU Method	ECHA, 2014A

Endpoint	Description	Reference
	B.10, OECD TG 473 for chromosome aberration with and without metabolic activation in the concentration ranges of 10-100 µg/mL. The test system showed no genotoxic effects. A bacterial reverse mutation assay was conducted according to OECD TG 471 with and without metabolic activation in the concentration range of 20-5000 µg/plate. The test system showed no genotoxic effects. Chromosome aberration was tested in an *in vivo* study with mice orally exposed to 525 – 21000 mg/kg of the test substance. The animals were sacrificed after 16, 24, and 48 hours leading to the conclusion that the test substance is not mutagenic.	
Carcinogenicity	No data.	
Reproductive toxicity	Developmental toxicity: Maternal toxicity and embryotoxicity was tested according to OECD TG 414 by dosing the dams 7 days/week for an unspecified time period in the concentration of 0, 100, 400, and 1000 mg/kg bw/day (nominal). No effects reported. Observed no effect levels were: NOAEL 1000 mg/kg bw/day (nominal) for maternal toxicity and NOAEL 1000 mg/kg bw/day (nominal) for embryotoxicitxy.	ECHA, 2014A
Other effects		

Endocrine disruption
Ethylhexyl Triazone is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.10 Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)

No harmonized classification is available for this substance and no notified classifications relevant for human health assessment are submitted (ECHA, 2014B). The substance is registered under REACH.

The summary is primarily based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

Bis-ethylhexyloxyphenol methoxyphenyl triazine is a highly lipophilic (log Kow > 5.7), and high molecular weight substance (MW = 627.8 g/mol). The substance can be recognized as well described with respects to its health properties, since many studies following official test guidelines are available., i.e. 1 toxicokinetics study, 3 oral exposure studies, 1 inhalation exposure study, 4 dermal exposure studies, as well as studies on irritation, sensitization, genetic toxicity, carcinogenicity and 5 studies on developmental toxicity (ECHA, 2014A).

A basic toxicokinetics study performed according to OECD guidelines concluded that the substance is excreted basically unchanged, rendering absorption and metabolism negligible. Dermal

absorption has likewise been shown to be negligible both in an *in vivo* rat study and an *in vitro* study with human skin (ECHA, 2014A). The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of bis-ethylhexyloxyphenol methoxyphenyl triazine in sunscreens and other cosmetic formulations.

Two irritation studies and a single sensitisation study indicate that the substance is neither irritating to skin or eye, nor acts as a skin sensitizer. In contrast, the repeated dose toxicity study with dermal exposure (Dermal, rat, 104 weeks, according to OECD TG 451) observed scab formation in rats in the dose group of 100 mg/kg/day. Those effects were observed after 104 weeks and no clear dose-response relationship could be established in this study, indicating that the effects are presumably not related to the treatment with the substance. This interpretation is supported by the results of the 90 d dermal exposure study (Dermal, rat, 90 d, according to OECD TG 411) (ECHA, 2014A).

Acute and repeated toxicity studies document low toxicity following oral exposure with NOAELs ranging from ≥ 1000 mg/kg/day to ≥ 2000 mg/kg/day. These values always represent the highest doses, which the animals were exposed to in the respective studies. The same applies to the dermal exposure studies, were the highest dose of 1000 mg/kg/day did not result in overall clinical effects. The NOAEL for acute and repeated dose toxicity following oral or dermal exposure can therefore be set at 1000 mg/kg/day (ECHA, 2014A).

Bacterial and mammalian cell assays show that the substance is not mutagenic or genotoxic (ECHA, 2014A).

The studies on carcinogenicity, reproductive toxicity, and developmental toxicity did not produce any effects at the applied dose ranges (0 -1000 mg/kg/day), resulting in NOAELs of ≥ 1000 mg/kg/day for those effects as suggested by the registrant (ECHA, 2014A). This value vill be used for the preliminary MOS calculation.

TABLE 53
HEALTH PROPERTIES OF BIS-ETHYLHEXYLOXYPHENOL METHOXYPHENYL TRIAZINE (CAS NO. 187393-00-6)

Endpoint	Description	Reference
Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)		
Toxicokinetics	A basic toxicokinetics study was performed according to OECD TG 417: Following a single oral dose of 50 mg [^{14}C]-marked substance/kg to male and female rats, excretion was rapid in both sexes, with 94-97% of the administered dose excreted directly in faeces within 96 hours as unchanged substance. This is consistent with the measured concentrations of radioactivity in blood and plasma of less than the limit of detection. Quantitatively, no sex difference was observed. Urinary excretion accounted for 0.1-0.3% of the dose, and residual radioactivity in tissues and carcass accounted for 0.1-0.3% of the dose. Residues in individual tissues were all <0.01% of the dose. Following oral dosing, it is considered that absorption of [^{14}C]-marked substance was very low. In summary: Absorption - negligable (blood samples below limit of detection at all time points) Excretion - 94% in faeces and 0.1% in urine (males), 97% in faeces and 0.2% in urine (females) Distribution - <0.01% of dose remained in tissues. No specific target tissue could be identified. 0.26% of dose (males) and 0.1% of dose (females)	ECHA, 2014A

Endpoint	Description	Reference
	remained in residual carcass. Metabolism - 99.6% of dose excreted as unchanged test substance. No metabolites could be identified. Dermal absorption study according to OECD 411: Male rats were treated with 0, 250, 500, 1000 (without collar), 1000 (with collar) mg/kg-bw and the percutaneous absorption rate was determined at days 8, 37, and 91, resulting in a rate of 0.01 – 0.06% for the highest dose group. The plasma levels of the test item measured in animals given 1000 mg/kg/day with or without collar were very low and indicated that the test item was not bioavailable by cutaneaous route. Because of the very low levels in the high-dose groups, the samples for lower dose groups were not analyzed.	
	The study evaluated the possible penetration through human skin of organic and inorganic filters contained in sunscreen emulsions packaged in aerosol cans, using an *in vitro* method with a membrane of human epidermis and dermis. Experiments were carried out on two different types of emulsions (W/O and W/Si). The substance was applied in a concentration of 1% in the W/O emulsion. After a penetration test of 24 h duration, the substance showed no potential of skin penetration at all. This can be explained by its high molecular weight (628 g/mol) and the low applied concentration (1% in W/O). No information on GLP compliance or test guidelines.	Durand et al., 2009
Acute toxicity	Oral exposure study following OECD TG 401: 5 male and 5 female rats were administered 2000 mg test substance/kg via gavage. The mean lethal dose after single oral administration to rats of both sexes, observed over a period of 14 days, could not be estimated, because no death occurred: LD50 > 2000 mg/kg. Acute Inhalation study following OECD TG 403: Male and female rats were exposed for 4 h to aerosols (nose only) containing 0.649 mg/L of the active ingredient. There was no indication of relevant sex-related differences in toxicity of the test item. A LOAEC of 0.649 mg/L air (analytical) was determined. The clinical signs observed could not be attributed to the active ingredient.	ECHA, 2014A
Irritation and corrosivity	Skin irritation study according to OECD TG 404: One male and two female rabbits were exposed to 0.5 g test substance for 4 h. Application of the test article to healthy intact rabbit skin resulted in a primary irritation score of 0.00. Local signs (mean values from 24 to 72 hours) consisted of grade 0.00 erythema and grade 0.00 edema. No irreversible alterations of the treated skin were observed nor were corrosive effects evident on the skin. Based on these observations and on the referred classification criteria, the test substance is considered to be "not irritating" to rabbit skin. Eye irritation study according to OECD TG 405: One male and two female rabbits were exposed once to 0.1 g test substance and observed for 72 h. Application of the test article to healthy rabbit conjunctivae resulted in a	ECHA, 2014A

Endpoint	Description	Reference
	primary irritation score of 0.44. Slight to moderate reddening and slight swelling of the conjunctivae were noted in all animals, as well as hyperemia of the scleral blood vessels and slight to moderate watery discharge. All findings were reversible after 48 hours. No corrosion of the cornea was observed at any of the reading times. Based on these observations and on the referred classification criteria, the test substance is considered to be "not irritating" to the eye.	
Skin sensitisation	Guinea pig maximisation test according to OECD TG 406: In this study 0% of the animals of the test group were observed with positive skin reactions after treatment with a non-irritant test article concentration of 30% in PEG 400. No skin reactions were observed in the control group. Therefore, the test substances applied at a concentration of 30% in PEG 400 is considered not to be a sensitizer when used under the described test conditions.	ECHA, 2014A
Subchronic/ repeated dose toxicity	90-Day Oral Toxicity in Rodents according to OECD TG 408: The oral administration of the test substances to Wistar rats at doses of 100, 500 or 1000 mg/kg/day, for at least 92 days, resulted in no evidence, either on the in-life or pathomorphologic parameters, of toxic effects of the test article. In particular, no adverse effect on the immune system was recorded and there was no evidence of any neurotoxic effect of the test article. The few changes noted in clinical biochemistry and urinalysis parameters were considered to be typical findings within the range of biological variation and the historical control data. Based on the results of this study, the NOAEL was ≥ 1000 mg/kg/day. GLP range-finding study, 14 d, oral, rats (male/female): 5 male and 5 female rats were exposed to 0, 50, 200, 800, 2000 mg/kg-bw/d by gavage. The treatment for a period of 14 days had no effect on survival, food consumption, body weights, ophthalmoscopy findings, clinical laboratory parameters, organ weights and macroscopic or microscopic findings, which could be attributed to the test article. Based on the results of this study, the NOAEL was ≥ 2000 mg/kg/day. Dermal, rat, 104 weeks, according to TG OECD 451:* Three test-treated groups of 100 rats (50 males and 50 females) received the test item at 100, 500 or 1000 mg/kg/day by daily cutaneous application for 104 weeks (under a dosage volume of 2.5 mL/kg/day). The NOAEL for overall effects (clinical signs and mortality, body weight, food consumption, haematology, organ weigths), including carcinogenicity, except for local irritation and resulting non-neoplastic complications was ≥ 1000 mg/kg/day. Scabs were seen on the application site at a higher incidence and severity in males treated at 100 mg/kg/day (corresponding to 0.075 mg/cm² per day) and in animals treated at 500 and 1000 mg/kg/day, without clear dose-relationship between 500 and 1000 mg/kg/day. GLP range-finding study, 15 d, dermal, rats (male/female): 5 male and 5 female rats were exposed to 0 and 1000 mg/kg-bw/d by by cutaneous application. The test item, when administered to the rats at the dose-level of 1000 mg/kg/day for 2 weeks, was clinically well tolerated. Slight desquamation was noted in treated females with a higher incidence than in controls. No necropsy findings were noted. Dermal, rat, 90 d, according to OECD TG 411:	ECHA, 2014A

Endpoint	Description	Reference
	The test item was administered dermally to rats at the dose-levels of 250, 500 and 1000 mg/kg/day for 13 weeks. No clinical signs, hematological, blood biochemical, urinary or histopathological findings were observed at any dose-level. Plasma levels indicated that the test item was not bioavailable. Consequently, under the experimental conditions of the study, the NOAEL of the test item was ≥ 1000 mg/kg/day. Desquamation (dermal irritation) was noted in males given 500 and 1000 mg/kg/day was no longer observed after 10 days of dosing and was not observed in females. This finding was explained by the fact that residues of the test item on the application site sometimes resembled desquamation. Scabs were most frequently noted in treated males. Although, this finding did not appear in controls, no dose-relationship could be observed. This finding was considered not related to the test item because the scabs were limited in frequency, did not occur in both high-dose groups, and readily resolved during the dosing period for most of the animals. Thus, this finding was not considered to be related to treatment with test item.	
Mutagenicity/ genotoxicity	*In vitro* Mammalian Chromosome Aberration Test according to OECD TG 473: The test article did not induce structural chromosome aberrations under and after irradiation with UV light. Therefore, the test item is considered to be not mutagenic in this chromosomal aberration test. Three further *in vitro* studies (1 Mammalian Chromosome Aberration Test according to OECD TG 473, 2 Ames tests according to OECD TG 47) concluded likewise that the substance is not mutagenic, with or without metabolic activation. Test with Mammalian Liver cells in vivo according to OECD TG 486: The test substance was not genotoxic.	ECHA, 2014A
Carcinogenicity	Dermal, rat, 104 weeks, according to TG OECD 451:* Three test-treated groups of 100 rats (50 males and 50 females) received the test item at 100, 500 or 1000 mg/kg/day by daily cutaneous application for 104 weeks (under a dosage volume of 2.5 mL/kg/day). Another group of 50 males and 50 females received no treatment and acted as an untreated control group. The daily treatment with the test item for 104 weeks induced only non-neoplastic findings at the treated skin area indicative of a chronic and moderate local skin irritation and substantiated that higher doses could not have been used. Consequently, under the experimental conditions of the study, the test item, was not carcinogenic by cutaneous application at 100, 500 and 1000 mg/kg/day (NOAEL ≥1000 mg/kg/day).	ECHA, 2014A
Reproductive toxicity	GLP guideline study suitable for the screening of reproductive function and early embryonic development according to guideline Japanese MHW (No. 316): 20 male and 20 female rats were exposed by gavage to doses of 0, 100, 300, and 1000 mg/kg-bw 14 days prior to pairing, through mating, and females only through early stages of pregnancy. It was concluded that the NOAEL is ≥1000 mg/kg for general toxicity in dams, for reproductive functions of parent animals, and for early embryonic development. Prenatal Developmental Toxicity Study according to OECD TG 414:	ECHA, 2014A

Endpoint	Description	Reference
	20 female rats were exposed by gavage to doses of 0, 100, 300, & 1000 mg/kg-bw/day at day 6 through to day 17 post coitum. Up to and including a dose level of 1000 mg/kg body weight/day, administration of the test item did not influence the development of dams, embryos or foetuses, resulting in a NOAEL for maternal and developmental toxicity of ≥1000 mg/kg/day. Four more GLP guideline studies (according to guidelines by the U.S. Food and Drug Administration, Japanese MHW and 2 GLP range finding studies) are available, using the same dose concentrations and similar test conditions. Two of the tests were performed with rats and the other two with rabbits. All tests conclude that the NOAEL for maternal and developmental toxicity was ≥1000 mg/kg/day.	
Other effects	No data.	

* Same study listed under both repeated toxicity and carcinogenicity because of the different endpoints tested.

Endocrine disruption

Bis-ethylhexyloxyphenol methoxyphenyl triazine is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.11 Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)

Harmonised classification with hazard class Aquatic chronic 4 and no notified classification relevant for human health are submitted (ECHA, 2014B). The substance is registered under REACH.

SCCP has published a revised opinion on the substance in 2008, from which most of the data presented here are taken (SCCP, 2008c). These data have been supplemented with data available in the REACH registration dossier (ECHA, 2014A) and a study on dermal penetration by Durand et al. (2009). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

Six dermal absorption studies (5 *in vitro* and 1 *in vivo*) with varying degree of reliability (valid, not valid, not known) are available from the SCCP opinion (SCCP, 2008c), the ECHA registration database and Durand et al. (2009). The *in vitro* studies are using different methodologies with pig, rat or human skin. Four of the *in vitro* studies reach similar conclusions; two of the studies conclude that the substance is not absorbed dermally, while another two studies identified a (very) low skin absorption of 0.10 ±0.12 µg/cm² or 0.04 ± 0.05% and 0.5% (with human skin). The *in vitro* study using rat skin identifies an absorption rate of 10.3% and the *in vivo* rat study an absorption rate of 2.3 – 3.2%. Based on species, validity/reliability considerations as specified by SCCP and on ECHAs homepage, the dermal absorption value of 0.5% is considered as appropriate for the risk assessment.

Only one study on acute toxicity with rats has been available, which indicated that the substance has low acute toxicity following oral exposure. This conclusion is based on a median lethal dose found to

be greater than 2000 mg/kg bw (SCCP, 2008c). The NOAEL from a single study on repeated dose toxicity was determined at 1249 mg/kg bw based on the highest concentration used.

Three irritation (skin and eye) and one sensitisation study document that the substance does not have irritating or sensitising effects on the skin, but may be transient irritating to the eye (SCCP, 2008c).

SCCP (2008c) presents three *in vitro* studies on mutagenic effects, all concluding that the substance is not mutagenic. This conclusion is supported by a single *in vivo* study with mice from ECHAs homepage. The phototoxic, -allergic, and mutagenic potential was investigated in three studies, all reaching negative results.

Two studies provided conclusions on developmental and reproductive effects with identified NOAELs ranging from 100 – 1000 mg/kg bw/day. The NOAEL of 100 mg/kg bw/day for several effects provided by the two-generation-study on ECHAs homepage is identified as the most sensitive endpoint and should therefore be used in the risk assessment.

TABLE 54
HEALTH PROPERTIES OF DIETHYLAMINO HYDROXYBENZOYL HEXYL BENZOATE (CAS NO. 302776-68-7)

Endpoint	Desription	Reference
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)		
Toxicokinetics	Dermal absorption study 1 according to OECD draft 428: Full-thickness pig skin (epidermis and dermis) was treated with a cosmetic formulation of 2 mg/cm² and 10 mg/cm²; active substance 200 µg/cm² and 1,000 µg/cm². Only 0.9% (group 2) respectively 1.0% (group 3) of the applied dose was found in the receptor compartment after the exposure period of 24 h. Therefore, the applicant assumed that most of the amount found in the epidermal membrane is located in the upper layers of the stratum corneum which will most probably not be absorbed. However, the SCCP did not considered the study as valid due to several shortcomings. Dermal absorption study 2 according to OECD draft 428: Full-thickness pig skin (dermatomed skin) was treated with a cosmetic formulation of 2 mg/cm² for 24 h, active substance 200 µg/cm². The experiment was performed in triplicate using 3 different pigs, and the skin biopsies (ca. 500 µm) were mounted into Franz diffusion cells. The mean recovery was 93%. No permeation of the test substance through the skin biopsies into the receptor medium could be observed. A minor amount (0.77%) was absorbed in the upper layers of stratum corneum, clearly graded from amounts within the deeper skin layers (0.100 ±0.115 µg/cm²; 0.042 ± 0.050%; max value 0.310 µg/cm²; 0.149%). The percutaneous absorption study no. 2 was considered as valid by the SCCP. The percutaneous absorption was 0.10 ±0.12 µg/cm² or 0.04 ± 0.05% (Maximum value 0.31 µg/cm² or 0.15%).	SCCP, 2008c
	The study evaluated the possible penetration through human skin of organic and inorganic filters contained in sunscreen emulsions packaged in aerosol cans, using an *in vitro* method with a membrane of human epidermis and dermis. Experiments were carried out on	Durand et al., 2009

Endpoint	Desription	Reference
	two different types of emulsions (W/O and W/Si). DHHB was applied in a concentration of 3.5% in the W/O emulsion. After a penetration test of 24 h duration, the substance showed no potential for skin penetration at all. This can be explained by its high molecular weight (397.5 g/mol), the high log Pow (6), and the relatively low applied concentration (3.5% in W/O). No information on GLP compliance or test guidelines.	
	Toxicokinetics study according to OECD TG 417: Absorption, distribution and excretion of the test substance was investigated in 24 rats (male and female) at dose level of 100 mg/kg bw. Absorption: The bioavailability was calculated as the sum of radioactivity found within 72 hours in bile, urine, cage wash, and carcass. Altogether, the bioavailability was 26% and 45% of the administered dose in male and female rats respectively. Distribution: Not determined. Excretion within 72 hours: Via bile: 11.28% for male rats and 19.76% for female rats. Via urine: 13.79% for male rats and 22.62% for female rats. Via faeces: 51.47% for male rats and 32.78% for female rats. In cage wash: 0.71% for male rats and 1.46% for female rats.	ECHA, 2014A
	Dermal absorption according to OECD TG 427: Rats were exposed for 12 hours with a 10% suspension resulting in a dose of 0.81 mg/cm². Absorption rates were determined after 12, 24 and 120 h to 3, 2.3, and 3.2%, respectively. Dermal absorption according to OECD TG 428: *In vitro* study with human skin obtained from 3 females. The mean applied dose, which was used for all skin specimens, was 1801.31 µg and exposure was 24 h. An absorption rate of 0.5% was calculated according to the SCCNFP/0750/03 opinion from the measurements of the test substance in the receptor fluid (0.02%), the "remaining skin" (0.11%) and in addition the second pool of the tape stripping (0.41%). Dermal absorption according to OECD TG 428: *In vitro* study with female rats exposed for 24 h to a cream formulation with 10% test substance. The mean applied dose was 1777.25 µg. An absorption rate of 10.3% was calculated according to the SCCP opinion from the measurements of the test substance in the receptor fluid (0.04%), the "remaining skin" (2.65%) and in addition the second pool of the tape stripping (7.65%).	ECHA, 2014A ECHA, 2014A ECHA, 2014A
Acute toxicity	Oral exposure study following OECD TG 423: 3 male and 3 female rats were administered 2000 mg test substance/kg bw via gavage of 10 mL. Under the conditions of this study the median lethal dose of the test substance after oral dosing was found to be greater than 2000 mg/kg bw for the male and female rats.	SCCP, 2008c

Endpoint	Desription	Reference
Irritation and corrosivity	Skin irritation study according to OECD TG 404: 3 rabbits were exposed to 0.5 g test substance for 4 h. Slight erythema was observed in 2 animals on the day of application. No oedema was observed. The third animal did not show any skin reactions. The cutaneous reactions were reversible in the animals within 48 hours after removal of the patch at latest. The average score (24 to 72 hours) for irritation was calculated to be 0.1 for erythema and 0.0 for oedema. Considering the observed cutaneous reactions as well as the average score for irritation, the test substance was not irritant to the skin under the test conditions. Repeated exposure skin irritation study (no guideline): 3 male and 3 female guinea pigs were exposed daily with 50 µL of a 10% or 20% solution in propylene glycol for 14 days. The readings of skin reactions were performed 24 hours after each application. Under the test conditions used in this study, the test substance concentrations did not cause skin reactions different from or discernibly more severe than those observed at the skin sites treated with the vehicle propylene glycol, alone. Furthermore, no concentration response relation was present. The study was performed following the "Guidance for cosmetic safety evaluation" issued by the Japan Cosmetic Industry Association 2001, the EMEA/CPMP guidance document and the method of Marzulli and Maibach, 1975. Study in compliance with GLP. Eye irritation study according to OECD TG 405: 3 rabbits were exposed once to 0.1 mL (about 40 mg) test substance, 24 hours after application, the eye was rinsed with tap water, and effects were observed after 72 h. Slight to moderate conjunctival redness was observed in all animals on the day of application. Additionally, slight discharge was seen in 1 animal. The ocular reactions were reversible in all animals within 48 hours after application at latest. The average score (24 to 72 hours) for irritation was calculated to be 0.0 for corneal opacity, iris and chemosis and 0.3 for conjunctival redness. The test substance caused transient irritation of the eye under the test conditions.	SCCP, 2008c
Skin sensitisation	Guinea pig maximisation test according to OECD TG 406: 10 young adult females in test group and 5 + 5 in control groups were exposed to the test substance in olive oil by intradermal and epicutaneously occlusive route. It was concluded that the test substance does not have a sensitising effect on the skin of the guinea pig in the Maximization Test under the test conditions. However, SCCP (2008) also notes that several questions may be raised concerning the study, causing that the study cannot be evaluated.	SCCP, 2008c
Subchronic/ repeated dose toxicity	90-Day Oral Toxicity in rats according to OECD TG 408: The oral administration of the test substances to Wistar rats at doses of 0, 600 ppm (males: approx. 51.7 mg/kg bw/day; females: approx. 59.3 mg/kg/d), 3,000 ppm (males: approx. 250.2 mg/kg bw/day;	SCCP, 2008c

Endpoint	Desription	Reference
	females: approx. 288.0 mg/kg bw/day), 15,000 ppm (males: approx. 1249 mg/kg bw/day; females: approx. 1452 mg/kg bw/day) for 90 days, revealed no substance-related effects in the clinical examinations and clinical pathology. The mean relative liver weights in male (+7%) and female rats (+10%) in high dose group were statistically significantly increased. However, the lack of any morphological changes supports the assumption that this is not an adverse effect. The study authors considered that the NOAEL was equal to the highest dose used. That is 15,000 ppm (1248.8 mg/kg bw/day in males; 1452.1 mg/kg bw/day in females). Based on the increase in relative liver weight, the NOEL was set at 3000 ppm (250 mg/kg bw/day).	
Mutagenicity/ genotoxicity	*Salmonella typhimurium/Escherichia coli* reverse mutation assay according to OECD TG 471: The test substance has been investigated for the induction of gene mutation in *Salmonella typhimurium* and *Escherichia coli*. The test substance is not mutagenic under the experimental conditions used. *In vitro Mammalian Cell Gene Mutation Test according to OECD TG 476:* The test substance was examined for its genotoxic potential in the L5178Y TK+/- mouse lymphoma test in the absence and presence of metabolic activation. The study authors concluded that under the experimental conditions reported the test item did not induce mutations in the mouse lymphoma thymidine kinase locus assay using the cell line L5178Y in the absence and presence of metabolic activation. Chromosome Aberration Assay in V79 Cells according to OECD 473: The test substance has been investigated for the induction of chromosome aberrations in V79 cells derived from Chinese Hamster. The test substance did not cause any increase in the number of structurally aberrant metaphases incl. and excl. gaps at both sampling times either without S-9 mix or after adding a metabolizing system in two experiments performed independently of each other.	SCCP, 2008c
	Mammalian Erythrocyte Micronucleus Test according to OECD TG 474: Chromosomal damage was investigated in male mice by 2 intraperitoneal administrations at a 24-hour interval at doses of 500, 1000, and 2000 mg/kg bw. Under the experimental conditions, the test substance has no chromosome-damaging (clastogenic) effect nor does it lead to any impairment of chromosome distribution in the course of mitosis (aneugenic activity) in bone marrow cells *in vivo*, even at systemically toxic doses.	ECHA, 2014A
Carcinogenicity	No data.	
Reproductive toxicity	Two-generation study according to OECD TG 416: Male and female rats were fed doses via diet of 0, 100, 300, 1000 mg/kg bw/day. A NOAEL of 100 mg/kg bw/day was developed for the offspring generation based on effects on growth and development, and also for	ECHA, 2014A

Endpoint	Desription	Reference
	the parental generation based on general toxicity (clinical signs and reduction in food consumption and body weights). The NOAEL for effects on fertility and reproductive performance was determined at 300 mg/kg bw/day. <u>Developmental toxicity</u> Prenatal Developmental Toxicity Study according to OECD TG 414: 25 mated rats were exposed by gavage to doses of 0, 40, 200, 1000 mg/kg bw/day at day 6 through to day 19 post coitum. Maternal toxicity, by transient salivation, reduced food consumption on day 6 - 13 p.c. and slight alterations in absolute and corrected body weight gain were noted at 1,000 mg/kg bw/day. There were no substance-induced, dose related influences on the gestational parameters and no signs of prenatal developmental toxicity, especially no substance induced indications of teratogenicity, up to and including the highest dose level (1000 mg/kg bw/day). The NOAEL for maternal toxicity is 200 mg/kg bw/day, while it is 1000 mg/kg bw/day (highest applied dose) for prenatal developmental toxicity.	SCCP, 2008c
Other effects	<u>Phototoxic and photoallergenic potential</u> Study was based on the method published by Unkovic et al., 1983: The phototoxic and photoallergic potential of the substance was investigated in male guinea pig with 5 or 10 animals per treatment group exposed topically to 0.2 mL of the test substance at the concentration of 10 or 20% (w/w) in olive oil. No cutaneous reactions which could be attributed to a photoirritant effect of the test substance were observed. The SCCP, however, comments that under the experimental conditions, two very specific wavelengths of UV radiation were used without information of the absorption spectra of the substance. Broadband UVA and UVB irradiation would have mimicked the intended use of this cosmetic UV-filter more appropriately. <u>Photomutagenicity</u> Reverse Mutation Assay according to OECD TG 471: This study was performed to investigate the substance's potential to induce gene mutations under irradiation with artificial sunlight according to the plate incorporation test and the preincubation test using several *Salmonella typhimurium* strains and an *Escherichia coli* strain. Under the experimental conditions reported, the test substance did not induce gene mutations by base pair changes or frameshifts in the genome of the strains used. The test substance is therefor considered to be non-mutagenic in this assay. Chromosome Aberration Test *in vitro* according to OECD TG 473: The test substance has been investigated for the induction of chromosome aberrations after exposure to UV light in V79 cells derived from Chinese Hamster. No biologically relevant increase in the number of cells carrying structural chromosomal aberrations was observed. SCCP concluded that under the experimental conditions reported the test substance was non-clastogenic in the absence and presence of irradiation in the *in vitro* chromosome aberration assay	SCCP, 2008c

Endpoint	Desription	Reference
	using the Chinese Hamster V79 cell line.	

Endocrine disruption

Diethylamino hydroxybenzoyl hexyl benzoate is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.12 Diethylhexyl butamido triazone (CAS No. 154702-15-5)

No harmonised classification is available and no notified classifications relevant for human health have been submitted (ECHA, 2014B). The substance is registered under REACH. The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

A study on skin penetration according to a proposed guideline has been performed showing *in vitro* a very low percutaneous absorption (less than 0.1% of the applied dose) and the substance was found not to be toxic to human skin cultures (ECHA, 2014). Acute and repeated dermal toxicity study in rats were not carried out apparently on the basis of the very low absorption rate (less than 0.1%) seen in the *in vitro* percutaneous absorption study using human skin. In this study, the test substance (UVASORB HEB) has been showed to have a percentage of absorption lower than 0.1% when applied with oil-in-water emulsion or isopropyl myristate after 24 hours. No skin absorption was observed when applied as a powder. The test substance is not absorbed systemically and hence could not show toxic potential (ECHA, 2014). The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of diethylhexyl butamido triazone in sunscreens and other cosmetic formulations.

In one acute oral toxicity study in rats (OECD TG 401) with a limit test at a fixed dose of 2000 mg/kg no significant treatment related effects were seen. Hence, the oral LD50 in rats is higher than 2000 mg/kg (ECHA, 2014).

One study on reproduction/developmental toxicity (OECD TG 421) showed some effects related to treatment of parents at the high dose applied (1000 mg/kg/day). NOAEL was considered at 500 mg/kg/day for toxicity. It is therefore clear that the substance was absorbed via gastro-enteric mucosa and distributed systematically. No effect was seen on mating activity (fertility) and on F1 animals at any dose level. No information is available concerning excretion rates (ECHA, 2014).

One skin (OECD TG 404) and one eye (OECD TG 405) irritation study did not show any local or systemic toxicity; in the eye irritation study the animals treated (2 out of three animals) showed slight ocular changes (not further specified) though fully reversible within 48 hours post instillation. In the skin sensitisation study (OECD TG 406) none of the test animals (guinea pig) reacted positively, and the test substance is hence considered not to be a sensitizer (ECHA, 2014).

The test substance was not mutagenic in any of the three mutagenicity studies performed (ECHA, 2014).

A single repeated administration (13-week, OECD TG 408) toxicity study in Wistar rats by oral application did not show any effects on any parameter determined. NOAEL is considered to be 831 mg/kg bw/day for males and 963 mg/kg bw/day for females (highest dose level). The lack of general effects and of the target organ toxicity contradicts that the test item is adsorbed and distributed systemically (ECHA, 2014). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 831 mg/kg bw/day as suggested by the registrant based on an oral repeated dose toxicity study will be used for the preliminary MOS calculation.

TABLE 55
HEALTH PROPERTIES OF DIETHYLHEXYL BUTAMIDO TRIAZONE (CAS NO. 154702-15-5)

Endpoint	Description	Reference
Diethylhexyl butamido triazone (CAS No. 154702-15-5)		
Toxicokinetics	No purpose design studies on kinetics have been found though an *in vitro* study on percutaneous absorption (mentioned under other studies below) showing an absorption between 0.26 and 1.54%.	ECHA, 2014A
Acute toxicity	Oral exposure study according to OECD 401. Five males and 5 females were administered 2000 mg/kg BW of the test compound by gavage. No animals died during the observation period. Body weight gain was considered within normal limits for animals of this strain and age. No appreciable macroscopic findings were evident in any treated rat. Under the conditions of this study, the median lethal dose of the test substance after oral dosing was found to be greater than 2000 mg/kg bw for the male and female rats. No data on inhalation nor dermal appl.	ECHA, 2014A
Irritation and corrosivity	Skin irritation (OECD TG 404 (Acute Dermal Irritation / Corrosion, 3 males) and eye irritation (OECD TG 405 (Acute Eye Irritation / Corrosion, 3 males), both performed on New Zealand White rabbits showed no skin irritation after application of 0.5 g/animal of undiluted test materiel under occlusion and only a transient (fully recovered after 48 hours, observed in two of three animals) ocular change (not specified) after instillation of 0.1 g of undiluted test material in one eye. The substance is considered neither skin nor eye irritating.	ECHA, 2014A
Skin sensitisation	Guinea pig maximisation test (OECD TG 406 (Skin Sensitisation) performed on 10 animals with 6 controls produced no positive reaction after challenge in any animals and are hence considered not sensitising.	ECHA, 2014A
Subchronic/ repeated dose toxicity	OECD TG 408 (Repeated Dose 90-Day Oral Toxicity in Rodents), 1997, Wistar, both sexes. Four groups each of 10 males and 10 females, age 4 weeks, received in the feed 0, 0.15, 0.5 or 1.5% w/w resp. for 13 weeks. None of the standard parameters determined showed any changes towards controls. Though the mean percentage of neutrophils was higher and that of lymphocytes lower than controls in all groups of female rats treated with the test substance, this was considered due to the relatively low neutrophil and high lymphocyte count in the control group. The differences were not reflected in dose-related or significant changes in the absolute numbers of these cell types and	ECHA, 2014A

Endpoint	Description	Reference
	are, therefore, regarded as chance findings, unrelated to treatment. Since ingestion of the test substance at dietary levels up to 1.5% for 13 consecutive weeks was tolerated without signs of toxicity, the dietary concentration of 1.5% was considered the no-observed-adverse-effect level under the conditions of this study. This dietary level provided a mean intake of 831 and 963 mg of the test substance per body weight/day in male and female rats, respectively.	
Mutagenicity/ genotoxicity	None of the three mutagenicity studies performed showed the test substance to be mutagenic. OECD TG 471, Ames' test (bacterial reverse mutation in five strains of s. Typhimurium, TA 1535, 1537, 98,100, 1538, with and without S9) OECD TG 476 (*In vitro* Mammalian Cell Gene Mutation Test), mouse lymphoma L5178Y cell line, heterozygous at the tk locus, with and without S9. OECD TG 473 (*In vitro* Mammalian Chromosome Aberration Test), Chinese hamster Ovary (CHO) with and without S9.	ECHA, 2014A
Carcinogenicity	No data.	
Reproductive toxicity	OECD 421 Reproduction/Developmental Toxicity Screening Test. Test substance was administered by gavage daily to males (from 14 days before mating and through mating) to females (from 14 days before mating through mating and gestation and until day 4 post partum). Doses 0, 250, 500 and 1000 mg/kg/day given dissolved in PEG. Dose volume 5 mL/kg bw. Ten males and 10 females per group. No effect were observed on any of the reproductive parameters (oestrous cycle, sperm measures and reproductive performance) at any dose level though clinical signs, body weight and food consumption was affected at the high dose level however not leading to changes in macroscopic pathology and histopathology. Males: At the highest dose (1000 mg/kg) males showed several clinical signs on general toxicity and had a lower body weight gain than controls during the first two weeks of administration, similarly the food consumption was lower in the same period, this leading to a lower body weight than the controls. One male rat was euthanized due to adverse clinical signs (treatment related). Females: Female rats at the high dose level showed similar clinical signs as the males. Body weight loss was observed during the second week of premating but was not observed later. However body weight and body weight-gain was comparable to controls during gestation and lactation whereas food consumption (absolute and relative) was unaffected judged over the whole administration period. One female rat was euthanized due to adverse clinical signs (treatment related). Offspring: Only clinical signs of offspring (four days old when euthanized) was determined though showing no difference from controls. The no-observable-adverse-effect-level (NOAEL) for general toxicity for the test substance is 500 mg/kg/day as mortality was observed in	ECHA, 2014A

Endpoint	Description	Reference
	both sexes at 1000 mg/kg/day, in addition to adverse clinical signs, reductions in body weight gain and/or net losses in body weight. The test substance did not affect the ability of male and female rats to mate and produce viable litters at any dosage level tested. In addition, there were no microscopic changes in the testes of male rats that would indicate that the test substance should be considered a reproductive toxicant at dosages as high as 1000 mg/kg/day. Therefore, the NOAEL for reproductive toxicity is greater than 1000 mg/kg/day. (It is remarked that this study obviously is a preliminary study that if showing any effect would have been followed by a genuine study fulfilling the current guidelines).	
Other effects	Cytotoxicity: no statistically significant differences in LDH leakage was observed between the test group 24 h after application. No damage in exposed skin cultures was noted.	

Endocrine disruption
Diethylhexyl Butamido Triazone is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.13 Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3)

No harmonised classifications. 1162 notifiers out of 1203 suggest that the substance should not be classified and 37 suggest only classification for aquatic toxicity (ECHA, 2014B). The substance is registered under REACH.

The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

According to the registration dossier (ECHA, 2014A) OMC shows a very low percutaneous absorption in humans. In an *in vitro* dermal absorption study with pig skin (2 or 7.5% OMC in oil-water lotion, oil-water cream or water-oil cream) no more than 4% of OMC was found to be absorbed (ECHA, 2014A). In an *in vitro* dermal absorption study with skin from naked rats (1, 3 and 10% OMC in carbitol) the skin penetration potential and resorption capacity of OMC were significant after longer times of exposure (up to 40-45%) (ECHA, 2014A).

The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for use of OMC in sunscreens and other cosmetic formulations.

According to the registration dossier (ECHA, 2014A) OMC is of low acute oral and inhalation toxicity, irritating to the skin, slightly irritating to the eyes, not a skin sensitiser, and does not possess mutagenic or genotoxic properties.

In a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 450 mg/kg bw/day was concluded (ECHA, 2014A). In a subacute dermal repeated dose toxicity studies performed in rats, a NOAEL of 5000 mg/kg bw/day for systemic toxicity was concluded; the skin irritation reactions observed in the study indicated that OMC is a low grade skin irritant in the rat (ECHA, 2014A). In a subacute dermal repeated dose toxicity studies performed in rabbits, a NOAEL of 1500 mg/kg bw/day for systemic toxicity was concluded; the grading of skin irritation reactions and microscopic observations in the study indicated that OMC is a moderate skin irritant in the rabbit (ECHA, 2014A). In a two-generation toxicity study in rats, a NOAEL of 450 mg/kg bw/day was concluded for systemic parental toxicity, fertility and reproduction parameters and developmental toxicity (ECHA, 2014A). In teratogenicity studies in rats and rabbits, a NOAEL for maternal and developmental toxicity of 1000 and 500 mg/kg bw/day, respectively, was concluded (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 450 mg/kg bw/day will be used for the preliminary MOS calculation.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

TABLE 56
HEALTH PROPERTIES OF ETHYLHEXYL METHOXYCINNEMATE (OMC) (CAS NO. 5466-77-3)

Endpoint	Description	Reference
Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3)		
Toxicokinetics	In two *in vivo* absorption studies in human subjects (n=4), dermal application of 4 or 10% (vehicle: carbitol) for 8 hours resulted in recoveries (%) ranging from 0.28 - 1 (skin) and 0.12 - 0.2 (urine) and 0.16 – 0.6 (skin) and 0.08 – 0.68 (urine), respectively. OMC was not detected in plasma or faeces. OMC shows a very low percutaneous absorption that is indicated by very high recovery of the dose from the skin, undetectable radioactivity in plasma and faeces and a very low percentage of applied dose excreted in the urine. Therefore, it can be concluded that OMC does not bioaccumulate in human under the study conditions. In an *in vitro* study on skin absorption (performed equivalent or similar to OECD TG 428) excised skin samples from mini pigs were exposed to 7.5 (^{14}C) or 7.5 (OMC 1789) + 2 (OMC ^{14}C)% solutions in oil-water lotion, oil-water cream or water-oil cream for 6 hours. The percutaneous absorption rate in oil-water lotion, oil-water cream and water-oil cream was 2.8% and 2.8%; 3.5% and 3.1% and 3.9% and 3.5% in solutions of 7.5% and 7.5+2%, respectively. There were no significant differences between the penetration rate values of OMC applied in different vehicles. No more than 4% of OMC was found to be absorbed in mini pig skin when applied in a concentration of 7.5% under the study conditions. In an *in vitro* study on skin absorption (performed equivalent or similar to OECD TG 428) excised skin samples from naked rats were exposed to 1, 3 or 10% (vehicle: carbitol) for 1, 6, 16 or 24 hours. The percutaneous absorption rate after 1, 3 and 10% solution was 1.7, 1.9, 2.1 and 44.3%; 21.3, 13.6, 12.8 and 35.6%; 39.7, 33.2, 22.8 and 22.7% after 1, 6, 16 and 24 hours, respectively. The skin penetration potential and resorption capacity of OMC were significant after longer times of exposure, based on the high amount of OMC found in the stripped skin, the low levels in the stratum corneum and the amount of activity recovered from the chamber liquid.	ECHA, 2014A
Acute toxicity	Acute oral LD50 > 5000 mg/kg bw in rats. Acute oral LD50 > 8000 mg/kg bw in mice.	ECHA, 2014A

Endpoint	Description	Reference
	Acute inhalation LC50 > 0.511 mg/L air in rats (OECD TG 403). Acute dermal LD50 > 126.3 mg/kg bw in rats (performed equivalent or similar to OECD TG 402) for a cream containing up to 7.5% OMC.	
Irritation and corrosivity	In an *in vivo* dermal irritation study (performed according to Fed. Reg. 38, No. 187, section 1500.41, p. 27019, Sept. 27, 1973), Vienna White rabbits (6 animals) were exposed to undiluted OMC for 24 hours. Mean erythema and oedema scores were 1.7 (grades 1 and 2 at 24-72 hours readings, grade 1 at 8-day reading) and 0.2 (grade 1 at 24 hour reading), and were fully reversible in 15 days and 48 hours, respectively. Albino rabbits (3 animals) were exposed to 0.1 mL undiluted OMC for 168 hours (not rinsed), 2 and 4 seconds (rinsed) in an *in vivo* eye irritation study. A slight irritation of the conjunctivae was observed during the few hours after application of pure OMC. This irritation was manifested by the presence of some more capillaries injected into the eye treated than on the eye not treated. No effect could be detected 24 hours after application of the test substance. No effect of rinsing was observed.	ECHA, 2014A
Skin sensitisation	No sensitization reactions were observed in an *in vivo* guinea pig maximization test (OECD TG 406).	ECHA, 2014A
Subchronic/ repeated dose toxicity	In a subchronic study (OECD TG 408), Füllinsdorf Albino SPF rats (12 animals/sex/group) were given dietary levels of 200, 450 and 1000 mg/kg bw/day for a minimum of 90 days. Effects on clinical signs (soiled tails); organ weights (reversible higher relative kidney weights) and non-neoplastic histopathology (reversible microscopical changes in the liver) in the high-dose group were observed. A NOAEL and LOAEL of 450 and 1000 mg/kg bw/day, respectively, were concluded. Deviations from OECD TG 408 included: number of animals in high-dose group (n=12) due to recovery experiment (n=6). In a subacute study, female Wistar rats (13 animals/group) were given dietary levels of 0 (control) or 1000 mg/kg bw/day for 35 days. Effects on body weight (lower), food consumption (lower) and clinical chemistry (higher thyroxine (T4) levels) were observed in the 1000 mg/kg bw/day group compared to control. A LOEL of 1000 mg/kg bw/day was concluded. In a subacute study (performed equivalent or similar to OECD TG 410) Sprague-Dawley rats (5 animals/sex/group) were applied doses of 500, 1500 or 5000 mg/kg bw/day on intact or abraded skin for 28 days (6 hours/day). No adverse effects were observed except for skin irritation reactions mainly in the high dose group. A NOAEL of 5000 mg/kg bw/day for systemic effects was concluded. The skin irritation reactions indicate that OMC is a low grade irritant under the experimental conditions. In a subacute study (performed equivalent or similar to EPA OPPTS 870.3200, Repeated Dose Dermal Toxicity – 21/28 days) New Zealand White rabbits (5 animals/sex/group) were applied doses of 500, 1500 or 5000 mL/kg bw/day on intact or abraded skin for 21 days (6 hours/day). Effects on clinical signs and mortality, dermal irritation, body weight, food consumption, haematology, clinical chemistry, organ weights, gross pathology and non-neoplastic	ECHA, 2014A

Endpoint	Description	Reference
	histopathology were observed mainly in the high dose group. A NOAEL of 1500 mg/kg bw/day for systemic toxicity was concluded. The grading of irritation reactions and microscopic observations during the study indicated OMC to be a moderate skin irritant under the prevailing conditions of the experiment.	
Mutagenicity/ genotoxicity	OMC was negative in an *in vitro* mammalian cell transformation assay (performed equivalent or similar to EU Method B.21) with Balb/c 3T3 clone A31-11 cells at concentrations up to 10 µg/mL. Deviations from EU Method B.21 included: Balb/c 3T3 cells used and in absence of metabolic activation system. OMC was negative in an *in vitro* DNA damage and repair assay (performed equivalent or similar to OECD TG 482) with freshly prepared hepatocytes from rats at concentrations up to 20 µg/mL. OMC was negative in an *in vitro* mammalian chromosome aberration test (performed equivalent or similar to OECD TG 473) with lymphocytes from human peripheral blood (with or without metabolic activation) at concentrations up to 50 µg/mL (with activation) and up to 20 µg/mL (without activation). OMC was negative in an *in vitro* bacterial reverse mutation assay (performed equivalent or similar to OECD TG 471) in *S. typhimurium* strains TA 1535, TA 1537, TA 98, TA 100 and TA 102 (with or without metabolic activation) in concentrations up to 5000 µg/plate. OMC was negative in an *in vitro* mammalian cell gene mutation assay (performed equivalent or similar to OECD TG 476) in Chinese hamster lung fibroblasts (V79) (with or without metabolic activation) in concentrations up to 20 µg/mL. Deviations from OECD TG 476 included: 2 hours treatment was performed with 3 concentrations of the test compound. OMC was negative in an *in vivo* micronucleus assay (performed equivalent or similar to OECD TG 474) in bone marrow derived polychromatic erythrocytes from mice (oral application 1000, 2500 and 5000 mg/kg bw).	ECHA, 2014A
Carcinogenicity	No data	
Reproductive toxicity	In a two-generation toxicity study (OECD TG 416), Wistar rats (25 animals/sex/group) were given dietary levels of 0, 150, 450 or 1000 mg/kg bw/day. A NOAEL for systemic parental toxicity, fertility and reproduction parameters and developmental toxicity of 450 mg/kg bw/day was concluded (systemic parental toxicity: based on body weight, gross pathology, organ weights and histopathology; fertility and reproduction parameters: based on secondary number of implantations sites and secondary delayed sexual maturation; developmental toxicity: based on pup weights). In a developmental toxicity study (performed equivalent or similar to OECD TG 414) Füllinsdorf albino rats (20-36 mated females/group) were given OMC at 250, 500 or 1000 mg/kg bw/day by gavage from day 7 to day 16 of gestation. No adverse effects were observed and a NOAEL of 1000 mg/kg bw/day for maternal toxicity and developmental toxicity was concluded (highest dose level). In a developmental toxicity study (performed equivalent or similar to OECD TG 414), Swiss rabbits (20 mated females/group) were given	ECHA, 2014A

Endpoint	Description	Reference
	OMC at 80, 20 or 500 mg/kg bw/day by gavage (vehicle: SSV: 0.5% carboxymethylcellulose, 0.5% benzyl-etOH, 0.4% TWEEN 80, 0.9% NaCl) on day 7 to day 20 of gestation. Body weight gain was slightly impaired in parental animals and significantly decreased in the foetuses in the highest dose group. A NOAEL of 500 mg/kg bw/day was established for both maternal and developmental toxicity. Deviations from OECD TG 414 included: The number of pregnant animals in the high dose groups is too low (13 of 20) and slightly over 10% of the animals in the high dose group died during the study (3 of 20).	
Other effects	OMC interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	Schiffer et al., 2014

Endocrine disruption

OMC is on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) and on the SIN list (SIN list database, 2014). In 2012, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Hass et al., 2012). Based on this evaluation, the substance can be considered a suspected endocrine disruptor with a concern for both human health and the environment. Under REACH the substance is on the CoRAP list and will undergoing substance evaluation (in 2015), with an initial concern for endocrine disruptive effects. This can lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH or a conclusion that the available data are adequate to conclude that the substance is not of concern. This is expected to be resolved in 2016.

5.3.14 Homosalate (CAS No. 118-56-9)

No harmonised classification is available. 77 out of 90 notifiers suggest that the substance should not be classified. 23 notifiers suggest classifications for homosalate to include Skin Irrit. 2 (H315), Eye Irrit. 2 (H319) and STOT SE 3 (H335) (ECHA, 2014B).

The substance is registered under REACH. The following summary is solely based on the SCCP (2007) opinion.

Rapid and complete metabolism of homosalate by esterases in the skin, plasma, liver and other body tissues to salicylic acid and trimethylcyclohexanol is assumed (SCCP, 2007). An *in vitro* dermal absorption study showed that application of a 10% homosalate-containing sunscreen led to mean dermal absorption of 8.7% in rats and 1.1% in human. The highest absorption found with human skin was 1.4 ± 0.4% with the highest absorption 2.0% (SCCP, 2007). The SCCP used the highest absorption of 2.0% for human for the calculation of the MOS (SCCP, 2007). The authors of this report agree with the evaluation of the SCCP; a dermal absorption of 2% will be used for the MOS calculation for use of homosalate in sunscreens and other cosmetic formulations.

The SCCP considered homosalate to be of very low acute toxicity, not to be irritating to the skin and the eyes, not to be photoirritating to the skin, not to be a skin sensitiser, not to be a photoallergen, and not to possess (photo)mutagenic or (photo) genotoxic properties (SCCP, 2007). Based on a 14-day oral repeated dose toxicity study performed in rats, a NOAEL of 100 mg/kg bw/day was derived. The SCCP used this NOAEL for the calculation of the MOS (SCCP, 2007). No data on reproductive toxicity were available to SCCP (SCCP, 2007).

Based on the assumed metabolism of homosalate and the comprehensive data base of the metabolites and in respect to structure relationship evaluations, SCCP considered that there is currently no need for further testing with respect to repeated dose toxicity or to reproductive performance and developmental toxicity (SCCP, 2007).

The authors of this report can agree with the evaluation of the SCCP; a NOAEL of 100 mg/kg bw/day will be used for the MOS calculation.

TABLE 57
HEALTH PROPERTIES OF HOMOSALATE (CAS NO. 118-56-9)

Endpoint	Description	Reference
Homosalate (CAS No. 118-56-9)		
Toxicokinetics	A comparative rat versus human *in vitro* percutaneous absorption study performed under current guideline requirements (Draft OECD TG 428) and under GLP conditions showed that application of a 10% homosalate containing sunscreen led to mean absorption of 8.7% (corresponding to 46.62 µg/cm²) in rats and to 1.1% (corresponding to 5.81 µg/cm²) in humans using freshly dermatomed skin. The highest absorption found with human skin was 1.4 ± 0.4% (7.63 ± 2.18 µg/cm²) with the highest absorption 2.0% (10.9 µg/cm²). 2% absorption is used in calculation of MOS. Beside this valid investigation, there are few *in vitro* and *in vivo* studies available with topical application of homosalate as constituent of preparations in varying concentrations dealing with different parts and aspects of dermal adsorption, absorption or penetration. The majority did not meet current testing guidelines and mainly qualitative but no quantitative conclusions could be drawn. No toxicokinetics study with homosalate *per se* was available to the SCCP. It is mentioned in the SCCP opinion that based on his evaluation Roberts (2005, unpublished data from Australia cited in the SCCP opinion) assumed rapid and complete metabolism of homosalate by esterases in the skin, plasma, liver and other body tissues to salicylic acid and trimethylcyclohexanol, both compounds with a complete and comprehensive data base.	SCCP, 2007
Acute toxicity	The acute oral and dermal toxicity of homosalate is very low. The respective LD50 values for the acute oral toxicity in rats and for the acute dermal toxicity in rabbits are far above >2000 mg/kg bw.	SCCP, 2007
Irritation and corrosivity	The limited data in experimental animals with respect to the irritative potential of homosalate did not indicate an irritation potential to the skin or the mucous membranes. Clinical studies in human revealed no irritative potential. Homosalate was proven not to be photoirritant in humans.	SCCP, 2007
Skin sensitisation	The existing data obtained in guinea pigs and mice showed no sensitizing potential of homosalate. Numerous clinical studies in human revealed no skin sensitizing potential of homosalate. No photosensitization was found in male and female guinea pigs and female mice after topical treatment. Homosalate possessed no photoallergic potential in humans in the	SCCP, 2007

Endpoint	Description	Reference
	available studies.	
Subchronic/ repeated dose toxicity	Data from a subacute oral 14-day range finding study in male and female rats performed with homosalate *per se* were considered as an indication that systemic toxicity might not be severe. From this study, a preliminary NOAEL of 100 mg/kg bw/day was derived. In the discussion section of the SCCP opinion, it is mentioned that it is suggested that homosalate is rapidly metabolized to salicylic acid and trimethylcyclohexanol. Both compounds are comprehensively toxicologically characterized and clear NOAELs covering all relevant endpoints for these compounds are available. The same is true for isophorone, which also has a trimethylcyclohexanol metabolite and for menthol as a compound with a similar structure to trimethylcyclohexanol. Thus, based on the assumed metabolism of homosalate and the comprehensive data base of the metabolites and in respect to structure relationship evaluations, it is considered that there is currently no need for further testing.	SCCP, 2007
Mutagenicity/ genotoxicity	No genotoxic/mutagenic potential was noted in three bacterial gene mutation assays in *Salmonella typhimurium* strains in the presence or absence of metabolic activation (one study performed according to OECD TG 471). In mammalian cells systems (Chinese Hamster V79 cell line), homosalate showed no clastogenic potential with or without metabolic activation (study performed according to OECD TG 473). No photo-genotoxic/mutagenic potential was noted in the bacterial gene mutation assays in *Salmonella typhimurium* strains (OECD TG 471) and no photo-clastogenic potential was recorded in the chromosome aberration test in Chinese hamster V79 cells (OECD TG 473), both with and without irradiation.	SCCP, 2007
Carcinogenicity	No data.	SCCP, 2007
Reproductive toxicity	No data. In the Discussion section of the SCCP opinion it is mentioned that based on the suggested metabolic fate of homosalate it can be stated that the metabolite salicylic acid is comprehensively investigated in respect to teratogenicity. Isophorone, which is also metabolized to trimethylcyclohexanol was tested for teratogenicity in multiple species and was negative. Menthol, which is structurally similar to trimethylcyclohexanol was investigated for reproductive toxicity and teratogenicity and revealed no adverse effects. Finally, it is considered that there is currently no need for further investigations in respect to reproductive performance and developmental toxicity.	SCCP, 2007
Other effects	*In vitro* homosalate was proven to be not phototoxic in the NRU assay (OECD TG 432) using murine BALB/c fibroblasts. *In vivo* there exists also no indication for a phototoxic potential in experimental animals. Homosalate interferes with functions of human sperm cells *in vitro*. Whether the observed effect on sperm motility should be considered as adverse to reproduction is not resolved.	SCCP, 2007 Schiffer et al., 2014

Endocrine disruption
Homosalate is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.15 Drometrizole trisiloxane (CAS No. 155633-54-8)

No harmonised or notified classification is available (ECHA, 2014B). The substance is pre-registered under REACH indicating that there is an intention to register the substance at the next submission deadline for registration of substances manufactured or imported at 1-100 tonnes per year on 31 May 2018.

Information on drometrizole trisiloxane is immensely sparse and restricted to general information on the substituted siloxanes. Therefore, this review is primarily based on information on the drometrizol component alone and the substituted siloxanes.

Apparently no relevant information has been published since the comprehensive report from the Danish EPA: "Siloxanes - Consumption, Toxicity and Alternatives" (Lassen et al., 2005), though it appears that L'Oreal USA Products Inc. has filed a dossier containing rather extensive information on the pre-clinical properties of drometrizole trisiloxane with the FDA. The content of this dossier is however not made publically available. From a published letter to L'Oreal from the FDA some information can however be derived as the reports contained in the dossier appear to cover essential aspects of the properties of the substance (FDA, 2014). This include acute studies in rats and mice with oral, dermal and intraperitoneal application; skin and eye irritation in rabbits and sensitising potential, phototoxicity and photoallergenicity as well as skin tolerance tests in Guinea pigs; thirteen weeks oral application to rats and 13 weeks dermal application to mice; ames' test, micronucleus test, chromosome aberration assay, reverse mutation, gene mutation and photomutation tests; fertility and embryofoetal toxicity (rats), embryofoetal toxicity (rabbit), pre- and post natal developmental toxicity (rats) and androgenic activity to immature castrated rats. In addition twelve months photocarcinogenicity study in hairless mice and 104 week cutaneous application in mice; pharmacokinetics after single oral and dermal application (rats and mice). The information which can be derived from the letter is limited, but the following can be deduced: drometrizole trisiloxane has no mutagenic potential, none of the reproduction studies performed point to a potential reproductive signal and the study of pharmacokinetics show systemic exposure after both oral and dermal application.

The following is excerpts from Danish EPA report (Lassen et al., 2005). Generally data on acute toxicity, skin and eye irritation, sensibilisation and genotoxicity represent no untoward toxicity related to siloxanes in general and short linear siloxanes in particular. Liver, kidney and lung are appointed as the target organs for changes resulting from exposure to siloxanes, however mainly by inhalation and for use in non-volatile products for use on skin the exposure via inhalation or ingestion is considered rather low. Dermal (percutaneous) absorption is most likely approx. 1% or lower (if comparable to cyclic siloxanes) but no figures are available.

Oral exposure to cyclic siloxanes in rats appears to lead to increased liver weight (hypertrophy) and induction of metabolising enzymes. Kidney affection (possibly hypertrophy) has also been observed suggesting that a possible excretion may be compromised by the siloxanes.

The drometrizole component of drometrizol trisiloxane is used in cosmetics as an ultraviolet (UV) light absorber and stabilizer. In an earlier safety assessment, the available data were found insufficient to support the safety of this ingredient, but new data have been provided and assessed.

In voluntary industry reports to the US Food and Drug Administration, this ingredient is reported to be used in noncoloring hair care products, and in an industry use concentration survey, uses in nail care products at 0.07% were reported. Drometrizole has absorbance maxima at 243, 298, and 340 nm. Drometrizole is used widely as a UV absorber and stabilizer in plastics, polyesters, celluloses, acrylates, dyes, rubber, synthetic and natural fibers, waxes, detergent solutions, and orthodontic adhesives. It is similarly used in agricultural products and insecticides. Drometrizole is approved as an indirect food additive for use as an antioxidant and/or stabilizer in polymers. Short-term studies using rats reported liver weight increases, increases in the activities of enzymes aminopyrine N-demethylase, and UDP glucuronosyl transferase, but no significant effects were noted in the activities of acid hydrolases or in hepatocyte organelles.

Although drometrizole is insoluble in water and soluble in a wide range of organic solvents, a distribution and elimination study using rats indicated that some drometrizole was absorbed, then metabolized and excreted in the urine. Drometrizole and products containing drometrizole were nontoxic in acute oral, inhalation, and dermal studies using animals. No increase in mortality or local and/or systemic toxicity were observed in a 13-week oral toxicity study using dogs; the no observed effect level (NOEL) was 31.75 mg/kg/day for males and 34.6 mg/kg/day for females. In a 2-year feeding study using rats, a NOEL of 47 to 58 mg/kg/ day was reported. Developmental studies of drometrizole in rats and mice found no teratogenic effects and a NOEL of 1000 mg/kg/day was reported. Drometrizole was not genotoxic in Ames tests, a mouse bone marrow micronucleus test, or somatic mutation assays observing interphase nuclei and chromosomal aberrations using Chinese hamsters.

There was no evidence of dominant lethal effects in studies using mice or rats. Drometrizole at a 1% concentration was minimally to moderately irritating to rabbit eyes, if followed by rinsing, but mildly to severely irritating in unrinsed eyes. A nail product containing 0.03% drometrizole, however, was nonirritating to unrinsed rabbit eyes. A nail polish containing 1.0% drometrizole was nonirritating to rabbit skin and drometrizole was negative for sensitization in two Magnusson-Kligman maximization tests in guinea pigs. In clinical tests, drometrizole at 1% was nonirritating in a single-insult patch test. No irritation or eczematous reactions were observed in 300 patients (with or without dermatosis) treated with daily applications of drometrizole for 8 weeks. In a 3-year clinical therapeutic trial conducted to evaluate the effectiveness of two UV absorbing preparations containing up to 5% drometrizole, two hypersensitivity reactions were observed during 445 applications.

Although there are case reports in which drometrizole was considered the sensitizing agent, clinical tests of cosmetic products containing 0.03% to 1.0% drometrizole produced no irritation, sensitization, photosensitization, or phototoxicity in a total of 436 subjects. The Cosmetic Ingredient Review (CIR) Expert Panel assumes that drometrizole is used in both noncoloring hair care and nail care products at low concentrations. The available safety test data do not suggest any adverse effects associated with exposure to drometrizole. This toxicologic profile, coupled with the low concentration of use and the unlikely dermal penetration of a chemical that is insoluble in water, support the conclusion that drometrizole can be safely used in cosmetics (CIR, 2008)

Above provided information and considerations lead to the conclusion that the toxic implications from use of drometrizol trisiloxane most likely are low to negligible.

TABLE 58
HEALTH PROPERTIES OF DROMETRIZOLE TRISILOXANE (CAS NO. 155633-54-8)

Endpoint	Description	Reference
Drometrizole trisiloxane (CAS No. 155633-54-8)		
Toxicokinetics	No data	
Acute toxicity	No data	
Irritation and corrosivity	No data	
Skin sensitisation	Drometrizole trisiloxane is listed as an agent causing exogenous photosensitivity.	Johansen et al. (ed.), 2011
Subchronic/ repeated dose toxicity	No data	
Mutagenicity/ genotoxicity	No data	
Carcinogenicity	No data	
Reproductive toxicity	No data	
Other effects	No data.	

Endocrine disruption
Drometrizole trisiloxane is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.16 Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)

Terephthalylidene dicamphor sulfonic acid has a harmonised classification as Eye Dam. category 1 (H318) (ECHA, 2014B). The substance is recently registered under REACH. .
An *in vivo* method in humans using radioactive test substance (^{14}C site not specified) showed an absorption determined up to 24 hours after a 4-hours exposure to 0.16% of the applied dose.

The following assessment is derived from the Australian authorities (NICNAS). This assessment is based on report summaries only. Full reports have not been available. In acute oral studies in rats using the acid, triethalanoamine salt, sodium and potassium salt, acute toxicity was found to be low with LD50 of >1,835, > 2,092, > 2,092 and > 2,092 mg/kg, respectively, and there was no evidence of systemic toxicity or abnormalities at necropsy. The acute dermal toxicity of the acid to rats was low with an LD50 of > 1,637 mg/kg. In a 90-day oral repeat dose study in rats, no dose related effects were found at 300 mg/kg/day. At 1,000 mg/kg/day there was phosphoremia in males at week 4 and decreased protein, albumin and globulin levels in females at week 13. There was some evidence of variation in thyroid weight in the male animals fed the test article, however, there was some doubt as to validity of this observation as the control animals were found to have unusually low thyroid weights. Follow up 21-day studies using the triethalanoamine and sodium salts (not audited) on thyroid metabolism found no treatment related changes at dose rates of 305 mg/kg and 444 mg/kg respectively. Skin irritation studies in rabbits found that the triethalanoamine, sodium

and potassium salts were non-irritant when 0.5 mL of a 10.4% aqueous solution was applied to exposed rabbit skin. A similar study using a 36.7% aqueous solution of the test chemical gave similar results. A stronger solution may produce irritant effects due to the strongly acidic nature of the notified chemical. Skin sensitisation tests using guinea pigs gave negative results with both the triethalanoamine salt (10.4% aqueous solution) and the acid (1% solution). Ocular irritation tests indicated that all three salts were irritants when 0.1 mL of a 10.5% test solution of each salt was applied to the eye of rabbits. The potassium salt had the highest index score of 8 out of a possible 110. Ocular irritation studies using the acid were not performed due to the inevitable results.

In teratogenic studies using the triethalanoamine salt in rats, no effects were found at doses up to 300 mg/kg/day. Genotoxicity studies using the triethalanoamine salt and *S. typhimurium* at doses up to 43,306 mg/plate, with or without rat liver S9, found no mutagenic effects. In additional studies using *E. coli* at doses up to 5,000 mg/ plate, with or without rat liver S9, no mutagenic effects were found. Other genotoxicity tests both *in vivo* (mouse micronucleus using acid) and *in vitro* (mammalian cell mutation using triethalanoamine salt) gave negative results at doses up to 2,000 mg/kg and 3,000 mg/ plate, respectively. On the basis of the strongly acidic nature of the test chemical it is classified as hazardous. The toxicological studies summarised above indicate that the neutralised acid and potassium salts produce minimal indications of toxicity in a wide range of tests with the exception of rabbit eye irritation studies. It is probable that the neutralised acid, potassium and sodium salts of terephthalylidene dicamphor sulfonic acid would be classified as hazardous due to the irritation effects found in the rabbit eye studies. The index scores have not been specified for corneal opacity, iris lesion, conjunctival erythema or oedema. A cautionary irritant classification on the basis of the overall index scores has been assigned, i.e. hazardous. Eye irritation studies using the acid were not performed due to the corrosive nature of the acid (NICNAS, 1996).

In a photomutagenicity study two complementary assay systems were used, one involving the induction of reverse mutations in *Escherichia coli* strain WP2, the other measuring the induction of chromosome damage in Chinese hamster ovary (CHO) cells. Irradiation with UVA and/or UVB was provided by an Osram Ultra-Vitalux sunlamp. None of the three sunscreens, tested either to the limit of solubility or toxicity, gave any indication of photomutagenicity in either assay, under conditions in which the positive control compound, 8-methoxypsoralen, was extremely photomutagenic. It is concluded that Mexoryls SL, SO and SX can be exposed to UV light without producing photomutagenicity measurable using a bacterial reverse mutation or a mammalian chromosome aberration assay (Dean et al., 1992).

A NOAEL of 300 mg/kg bw/day based on an oral repeated dose toxicity study wil be used for the preliminary MOS calculation

TABLE 59
HEALTH PROPERTIES OF TEREPHTHALYLIDENE DICAMPHOR SULFONIC ACID (CAS NO. 92761-26-7)

Endpoint	Description	Reference
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)		
Toxicokinetics	To supply a not reported *in vitro* method using isolated human skin (and apparently overestimating the absorption) an *in vivo* method in humans using radioactive test substance (^{14}C site not specified) showed an absorption determined up to 24 hours after a 4-hours exposure to 0.16% of the applied dose.	Benech-Kieffer et al., 2003
Acute toxicity	Oral toxicity in SD rats (limit test) according to OECD TGs with 5 males and 5 female rats. A dose of 5,000 mg/kg of a solution containing 36.7% active substance produced no mortality, no morphological findings and the body weight-gain was normal.	NICNAS, 1996

Endpoint	Description	Reference
	Oral LD50 above 1,835 mg/kg. Dermal toxicity in SD rats (limit test) according to OECD TGs with 10 animals of unspecified sex. Exposure with 1,637 mg/kg to clipped skin (area not specified) under occlusion for 24 hours with rinse thereafter produced neither mortality nor skin irritation with normal body weight-gain. Dermal LD50 above 1,637 mg/kg.	
Irritation and corrosivity	Skin irritation tests on 3 NWZ rabbits of unspecified sex according to OECD TGs with an observation period of 72 hours were performed. A dose of 0.5 mL of an aqueous solution (36.7% active substance) was applied to the clipped area (size not specified) of the back under occlusion with an exposure period of 4 hours. No irritation was observed. Draize score : 0. Three eye irritation tests (according to OECD TGs) were performed with neutralisation of the active substance with either: Trietanolamine, KOH or NaOH. Each study were performed with 6 male NWZ rabbits with an observation period of 7 days, instillation of 0.1 mL per eye of a solution (neutralised as mentioned above) containing 10.5% active substance. Draize score (maz 110): 4.67, 8, 6.33, respectively. Classification: irritant.	NICNAS, 1996
Skin sensitisation	Method not accurately described but apparently Guinea Pig Maximisation Test with 20 Dunkin Hartly Guinea Pigs. Active substance neutralised with triethanolamine in a concentration of 10.5%. Freunds adjuvant was used together with the active substance applied under occlusive patch. Challenge after 24 or 48 hours showed no reaction. Test substance was not sensitising.	NICNAS, 1996
Subchronic/ repeated dose toxicity	A 90 days oral toxicity study in SD rats, according to OECD TGs, with four dose groups, each of 10 males and 10 females, received 0, 100, 300 or 1000 mg/kg. No treatment related clinical signs were observed, necropsy revealed a variation in thyroid weights in males though the controls showed an unusually low thyroid weight why this observation is of doubtful significance. Clinical chemistry in high dose males showed decreased levels of phosphorous and decreased levels of protein (albumin and globulin) in high dose females. Histopathology showed no alterations towards controls. NOAEL considered to be 300 mg/kg.	NICNAS, 1996
Mutagenicity/ genotoxicity	Ames' test (Bacterial Reverse Mutation Test, OECD) employing TA 98, TA 100, TA 1535, TA1537, TA 1538 and *Escherichia coli* WP2uvrA, with and without S 9 using concentrations from 367 - 43,306 mg/ plate showed no effect. Micronucleus Assay in the Bone Marrow Cells of the Mouse (OECD compliant) using 2 groups each of 5 male and 5 female Swiss OF1 mice received by oral gavage 2000 or 3000 mg/kg by single application. No clastogenic effect were observed.	NICNAS, 1996

Endpoint	Description	Reference
	Photomutagenicity: Two assays were used, reverse mutations in *Escherichia coli* strain WP2 and Chinese hamster ovary (CHO) cells. Irradiation with UVA and/or UVB was provided by an Osram Ultra-Vitalux sunlamp. The test substance can be exposed to UV light without producing photomutagenicity.	Dean et al., 1992
Carcinogenicity	Dedicated carcinogenicity studies have not been found though an investigation on photocarcinogenicity in nude mice show the test substance to have a higher protective effect towards sun (UVR) induced tumours compared to other UV filters.	Foutainer et al., 1992.
Reproductive toxicity	No data	
Other effects	No data	

Endocrine disruption
Terephthalylidene dicamphor sulfonic acid is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not.

5.3.17 Isoamyl p-methoxycinnamate (CAS No. 71617-10-2)

No harmonised classification or notified health classification is available (ECHA, 2014B). The substance is registered under REACH.

The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

According to the registration dossier (ECHA, 2014A) isoamyl p-methoxycinnamate shows a very low percutaneous absorption in humans. In an *in vivo* cutaneous penetration test in rats, around 11% of isoamyl p-methoxycinnamate in a water in oil emulsion was absorbed following application for 24 hours (ECHA, 2014A). In an *in vitro* dermal absorption study with pig skin (methoxycinnamic acid isoamylester in an oil-water lotion and in a water in oil lotion) the test substance remained predominantly on the skin surface; the absorbed test substance was found predominantly in the horny layer (83-94%) (ECHA, 2014A). The authors of this report cannot conclude on a dermal absorption based on the available data. A dermal absorption of 10% will be used for the preliminary MOS calculation for use of isoamyl p-methoxycinnamate in sunscreens and other cosmetic formulations.

According to the registration dossier (ECHA, 2014A) isoamyl p-methoxycinnamate is of low acute toxicity, slightly irritating to the skin, not irritating to the eyes (based on two *in vitro* tests), not a skin sensitiser, and does not possess mutagenic or genotoxic properties.

In a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 200 mg/kg bw/day was concluded (ECHA, 2014A). In a teratogenicity study in rats, a NOAEL for maternal and

developmental toxicity of 0.75 mL/kg bw/day (ca. 750 mg/kg bw/day) was concluded (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 200 mg/kg bw/day will be used for the preliminary MOS calculation.

No data on phototoxicity are included in the Registration dossier (ECHA, 2014A).

TABLE 60
HEALTH PROPERTIES OF ISOAMYL P-METHOXYCINNAMATE (CAS NO. 71617-10-2)

Endpoint	Description	Reference
Isoamyl p-methoxycinnamate (CAS No. 71617-10-2)		
Toxicokinetics	The *in vivo* cutaneous penetration of ^{14}C-labelled para-methoxycinnamic acid isoamylester (mixed isomers) in two formulations (water in oil emulsions) was investigated in 6 healthy subjects. Doses of 0.157 (Formulation I) or 0.164 mg/cm^2 (Formulation II) were applied for 30 min. More than 50% of the administered ^{14}C-radioactivity was recovered in the first two strips. This amount is considered to be superficially deposited. A mean of 94.3% of the administered amount of ^{14}C-radioactivity was recovered in the 20 strips with formulation I and 88.5% with formulation II. The difference between the formulations was not statistically significant. The predominant amount of the ^{14}C-radioactivity was therefore detected on or in the epidermis. In the upper layers of the epidermis more ^{14}C-activity was found than in the lower ones. 0.5% of the applied ^{14}C-activity was still detected in the last strip. These results suggest that the test substance has not significantly penetrated into the skin of human volunteers from either of formulations. The *in vivo* cutaneous penetration of ^{14}C-labelled para-methoxycinnamic acid isoamylester (mixed isomers) in two formulations (Formulation I: an oil in water emulsion; Formulation II: a water in oil emulsion) was investigated in Sprague-Dawley rats. A dose of 18-23 mg of the test substance was applied per animal and the duration of exposure was 24 hours to 7 days. Absorption increased with time. The radioactivity in and on the treated area of the skin decreased with the duration of the percutaneous application. The absorbed amount of ^{14}C-labelled test substance was excreted mainly via urine. The amount of ^{14}C remaining in the carcass was rather low (0.01 - 1.5%) at the different times after application, indicating that the absorbed amount was excreted rapidly. Relatively highest ^{14}C-concentrations were detected in kidney, liver, and fat, lowest in brain. Intermediate concentrations were found in blood, thyroid, adrenals, gonads, lungs, muscle, heart, and spleen. Around 11% of the ^{14}C-amounts of the applied activity in Formulation II was absorbed following application for 24 hours. The dermal absorption / penetration of methoxycinnamic acid isoamylester (mixed isomers) in two formulations (Formulation I: an oil in water lotion; Formulation II: a water in oil lotion) was determined in an *ex vivo* / *in vitro* model (using excised porcine back skin) at 3, 6, 16 and 24 hours after topical application to the skin samples. In both lotions the test substance remained predominantly on the skin surface. The absorbed test substance was found predominantly in the horny layer (83-94%). The absorbed amount in the epidermis was quite low, whereas in the dermis only traces of it could be detected. The test substance was absorbed faster and to a higher extent in the w/o-lotion than in the o/w-lotion. Only	ECHA, 2014A

Endpoint	Description	Reference
	with the w/o-lotion, the contents of the test substance increased distinctively with exposure time; so after 3 hours exposure, 24% was absorbed by the skin, thereafter increasingly steadily to about 58% after 24 hours of exposure. In contrast, the test substance in o/w-lotion was absorbed by the skin to an extent of 16% after 3 hours, 33% after 6 hours, and, at both later time points, only a small further increase of the absorption to 37% took place.	
Acute toxicity	Acute oral LD50 approx. 9,900 mg/kg bw in male rats and approx. 9,600 mg/kg bw in female rats. Acute dermal LD50 > 20,000 mg/kg bw in rats (OECD TG 402).	ECHA, 2014A
Irritation and corrosivity	In a primary skin irritation study (OECD TG 404), SPF albino rabbits (4 females) were exposed to undiluted (100%), 20, 10, 5 or 1% solutions (vehicle: Ethanol 96% and diethyl phthalate in a ration 1:1 (w/w)) for 4 hours. Slight skin erythema was observed at 1 to 48 hours after termination of exposure of the neat test article (mean score of 0.3); no oedema was reported. The test substance was found to be not irritating to the skin of rabbits. Isoamyl p-methoxycinnamate (undiluted, 10 and 1%) did not exhibit any ocular irritating potential *in vitro* in the Bovine Corneal Opacity and Permeability Test Method for Identifying Ocular Corrosives and Severe Irritants (OECD TG 437). Isoamyl p-methoxycinnamate was found to be "practically non-irritant" in the Hen's Egg Chorionallantoic Membrane Test (HET-CAM-Test) when tested in concentrations of 1 and 10% in olive oil.	ECHA, 2014A
Skin sensitisation	No sensitization reactions were observed in an *in vivo* guinea pig maximization (OECD TG 406).	ECHA, 2014A
Subchronic/ repeated dose toxicity	In a subchronic study (OECD TG 409), Wistar rats (15 animals/sex/group) were given 0, 20, 200 or 2000 mg/kg bw/day by gavage (vehicle: polyethylene glycol) 7 days/week for 90 days. Effects on body weight, haematology, clinical chemistry and organ weights were seen in the high-dose group. A NOAEL of 200 mg/kg bw/day was concluded. In a subacute study, Sprague-Dawley rats (5 animals/sex/group) were given 0.3, 0.9 or 2.7 mL/kg bw/day by gavage (vehicle: 0.8% aqueous hydroxypropyl cellulose gel) for 21 days. Effects on appearance, body weight, food consumption, neurobehaviour and organ weights were observed in the high dose group, while only effects on organ weights were observed in the 0.9 mL/kg bw/day dose group. A LOAEL within the range from 0.9 to 2.7 mL/kg bw/day was concluded.	ECHA, 2014A
Mutagenicity/ genotoxicity	Isoamyl p-methoxycinnamate was negative in an *in vitro* mammalian cell gene mutation assay (OECD TG 476) with Chinese hamster lung fibroblasts (V79) (with or without metabolic activation) at concentrations up to 80 µg/mL (without activation) and up to 2500 µg/mL (with activation. Isoamyl p-methoxycinnamate was negative in an *in vitro* mammalian chromosome aberration test (OECD TG 473) with lymphocytes from human peripheral blood (with or without metabolic activation) at concentrations up to 300 µg/mL (with	ECHA, 2014A

Endpoint	Description	Reference
	activation) and up to 100 µg/mL (without activation). Isoamyl p-methoxycinnamate was tested in four *in vitro* bacterial reverse mutation assays (comparable / largely comparable / relatively similar to OECD TG 471) in *S. typhimurium* strains TA 1535, TA 1537, TA 1538, TA 98 and TA 100 with or without metabolic activation. Isoamyl p-methoxycinnamate did not show any mutagenic effects in any of the tested strains in concentrations up to 25,313 µg/plate; except for one study where isoamyl p-methoxycinnamate was positive in strain TA 100 (without activation) at 75 and 150 µL/plate. Isoamyl p-methoxycinnamate was negative in an *in vivo* micronucleus assay (bone marrow cells) (comparable to OECD TG 474) performed in mice (intraperitoneal application 750, 1,500, 3,000 mg/kg bw).	
Carcinogenicity	No data.	
Reproductive toxicity	In an developmental study (OECD TG 414) Wistar rats were given oral doses of 0.25, 0.75 or 2.25 mL/kg bw/day (vehicle: olive oil). The study duration was 20 days after day 0. In the highest dose group, 2 of 21 animals died (10%); the probable cause of death is substance-related erosion of the epithelium of the gastro-intestinal tract which led to gastro-intestinal bleedings. A decreased body weight was also observed in the high dose group. Higher incidences of intra-uterine mortality and lower foetal weights were observed in the highest dose group. A NOAEL for maternal and developmental toxicity of 0.75 mL/kg bw/day was concluded.	ECHA, 2014A
Other effects	No data.	

Endocrine disruption

Isoamyl p-methoxycinnamate is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). In 2013, publicly available data on endocrine disruptive properties of the substance was collected and evaluated by the Danish Centre on Endocrine Disruptors (Axelstad et al., 2013). The overall conclusion of the evaluation was, that there is not enough data to conclude whether the substance has endocrine disruptive properties or not. Under REACH the substance is on the CoRAP list and will undergo substance evaluation (in 2015), with an initial concern for endocrine disruptive effects due to strutural similarity to 2-ethylhexyl 4-methoxycinnamate (OMC). This can lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH or a conclusion that the available data are adequate to conclude that the substance is not of concern. This is expected to be resolved in 2016.

5.3.18 Benzophenone (BP) (CAS No. 119-61-9)

No harmonised classification. 2,706 notifiers have submitted a classification proposal. 935 have suggested a classification as STOT RE 2 (H373, liver, kidney), 247 have suggested Skin Irrit. 2, 212 have suggested Eye Irrit. 2, 122 have suggested STOT SE 3 (liver, kidney), 11 have suggested Acute Tox. 4 and and only 1 has suggested Carc. 2 (ECHA, 2014B). The substance is registered under REACH.

The summary is almost solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

The kinetics (ADME) of benzophenone has been investigated in a number of independent studies and adjacent to the NTP carc. studies in rats and mice (ECHA, 2014A). Benzophenone is metabolised to benzhydrol, p-hydroxybenzophenone and its sulfate conjugate, by hepatocytes *in vitro* (ECHA, 2014A).

Absorption after oral administration in both rats and mice derive results for AUC comparable to iv administration why absorption from the GI tract is evident, which also appear from the results from the other studies. Enterohepatic recirculation is clear after intravenous administration and does most likely also take place after oral administration. Dermal absorption (in monkeys) is observed to be high (approx. 70%) under occlusion though lower without (ECHA, 2014A).

Acute oral toxicity is determined in mice in a valid study (LD50 = 2895 mg/kg) and in rats in an old but most likely valid study (LD50 above 10,000 mg/kg) and in rabbits after dermal application (LD50 3535 mg/kg) (ECHA, 2014A).

Two studies of skin irritation have been found; one valid study showing no irritation to intact skin and one less valid study showing moderate irritation to both intact and abraded (method not specified) skin, both studies performed on rabbits. Eye irritation was tested *in vivo* in rabbit in two old studies using chrystalline test material not showing irritation (ECHA, 2014A).

Sensitisation was tested in two studies in Guinea pigs one Guinea pig maximasation assay and one Magnusson & Kligmann test; both showing no effect. This result is supported by results from an extensive study in human volunteers also shoving no sensitisation (ECHA, 2014A).

Three studies with repeated oral administration to rodents were found; two in rats and one in mice all performed with addition of the active substance to the diet. The two studies performed by NTP (one in rats and one in mice) both used doses too high to obtain a NO(A)EL (1.250, 2.500, 5.000, 10.000, or 20.000 ppm) whereas the third study employed lower dose levels enabling a NOAEL to be determined to 20 mg/kg. The liver (showing disorganization of lobular architecture and hepatic cords, nuclear hyperchromatia, and hepatocellular necrosis), kidneys and bone marrow (showing degerative effects) are the target organs. Enzyme-induction of the same type as after phenobarbital have been detected (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 20 mg/kg bw/day will be used for the preliminary MOS calculation.

Benzophenone was found to be non-mutagenic both *in vitro* and *in vivo* studies (ECHA, 2014A).

Three reproduction studies have been found, one two-generation study in rats and two developmental studies, one in rat and one in rabbits. In rats benzophenone shows the same effects on parents as in the other repeated dose studies though the effect on viability appears to be low. Developmental studies showed no abnormalities/malformations but skeletal variations and reduced foetal weight in both species was seen (ECHA, 2014A).

Two carcinogenicity studies were found, both performed by NTP. Benzophenone was administered to groups of 50 animals for 2 years. Male and female rats and mice received 312, 625, or 1,250 ppm of benzophenone in their feed (the highest concentration corresponding to 0.125%). Groups of

animals receiving untreated feed served as controls. Tissues from more than 40 sites were examined for every animal (ECHA, 2014A).

Almost all of the male rats receiving the highest concentration died before the end of the study. Male and female rats and female mice receiving benzophenone weighed less than the controls. Male rats receiving benzophenone had more severe kidney nephropathy than control animals and higher incidences of kidney tumors and leukemia. Female rats receiving benzophenone also had slightly higher rates of leukemia. Male and female mice had slightly increased rates of liver tumors and also increased severities of kidney nephropathy, metaplasia of the epithelium of the nose, and hyperplasia of the spleen. Some female mice also developed rare histiocytic sarcomas (ECHA, 2014A).

It is concluded that benzophenone caused kidney cancer in male rats, liver tumors in male mice, and histiocytic sarcomas in female mice. Benzophenone may also have been associated with development of leukemia in male and female rats and with liver tumors in female mice. Dermal application in life-time studies in mice (Swiss mice, females only) and rabbits (NWZ) showed no carcinogenic potential of benzophenone (ECHA, 2014A).

TABLE 61
HEALTH PROPERTIES OF BENZOPHENONE (BP) (CAS NO. 119-61-9)

Endpoint	Description	Reference
Benzophenone (BP) (CAS No. 119-61-9)		
Toxicokinetics	Benzophenone at a low-toxic level (0.25 mM) in the hepatocyte suspensions was converted to benzhydrol, p-hydroxybenzophenone and its sulfate conjugate.	ECHA, 2014A
	A single dose of 2.5 mg/kg bw of benzophenone were administered intravenously to male and female F344/N rats. Concentrations of benzophenone were determined in plasma at various timepoints up to 24 hours after dosing. After intravenous administration to females, the elimination rate constant (kelim) was slightly higher than after gavage administration, with a concomitant decrease in t½ elim (kelim = 0.00280 min^{-1}; t½ elim = 247 min). Overall, there were no apparent sex-related differences in noncompartmental pharmacokinetic parameter estimates for rats.	ECHA, 2014A
	Doses of 2.5, 5.0 and 10.0 mg/kg bw of benzophenone were administered as single dose by gavage to male and female F344/N rats. Concentrations of benzophenone were determined in plasma at various timepoints up to 24 hours after dosing. For males, bioavailability after a gavage dose ranged from 0.824 to 1.27, with an average value of 1.09. Estimates of elimination rate constants and half-lives (kelim and t½ elim, respectively) for males were (kelim ca. 0.00270 min^{-1}; t½ elim ca. 255 min), with slight decreases in kelim and concomitant increases in t½ elim at the two higher gavage doses (kelim ca. 0.00130 min^{-1}; t½ elim ca. 550 min). For female rats, estimates of kelim and t½ elim were similar for the three gavage doses (kelim ca. 0.00150 min^{-1}; t½ elim ca. 485 min). Bioavailability for females ranged from 1.05 to 1.39, with an average value of 1.18.	ECHA, 2014A
	Doses of 15, 30, or 60 mg/kg bw of benzophenone were administered as single dose by gavage to male and female B6C3F1 mice. Concentrations of benzophenone were determined in plasma at various timepoints up to 24 hours after dosing. In mice, the AUCs were supralinear with respect to dose; as the dose was increased, the	ECHA, 2014A

Endpoint	Description	Reference
	AUC/dose also increased. The nonlinearity in mice may be due to a first-pass effect of liver metabolism restricting the amount of benzophenone that gets into the general circulation. As the dose is increased, the first-pass metabolism becomes saturated. Mice appear to metabolize benzophenone more rapidly than rats; the doses are higher for mice, yet the half-lives and AUCs are smaller. There were no obvious sex-related differences in noncompartmental pharmacokinetic parameter estimates for mice. The percutaneous absorption of benzophenone was determined *in vivo* in monkeys. Absorption through occluded skin was high (about 70% of the applied dose within 24 hours). Under unoccluded conditions skin penetration was reduced, presumably because of evaporation.	ECHA, 2014A
Acute toxicity	Benzophenone was administered by oral gavage as single application to Swiss mice to determine the acute toxicity. Necropsy was performed 7 days after administration of the test item. Clinical signs at lethal doses were sedation, progressive depression of motor activity, unstable gait, tremors and respiratory impairment. The acute oral toxicity (LD50) in mice was determined by Probit analysis at 2,895 mg/kg bw. In an old (1979) study in rats the oral LD50 was determined to above 10,000 mg/kg. In another also old (1979) study the dermal LD50 was determined in rabbits at 3,535 mg/kg.	ECHA, 2014A
Irritation and corrosivity	A primary skin irritation study was performed in rabbits (MOL:Russian) according to OECD 404 (1992). Benzophenone was tested at concentrations of 2, 5, 10, 25 and 100%. No signs of skin irritation were observed at any of the concentrations tested. Benzophenone is not a skin irritant. In an old study (1977) benzophenone was applied as a 20% dispersion in olive oil to the rabbit (NZW) skin. The skin was scored for irritation at 24 and 72 hours. Benzophenone had a moderate irritating potential to the scratched and unscratched skin sites with histopathological changes. No information was available about the exposure time of the test item. Two *in vivo* studies (both from mid-eighties) in rabbit eye without specification of method used, but using crystalline benzophenone, caused no irritation/corrosion.	ECHA, 2014A
Skin sensitisation	Benzophenone was applied to 10 Guinea pigs in a modified Draize test. (OECD TG 406). After induction (Day 0) with 4 intradermal injections to each animal with a 1% benzophenone concentration, combined intradermal (0.25% benzophenone) and topical challenge (20% benzophenone) procedures followed on day 14 and were repeated on days 35 and 42. Benzophenone did not show a sensitising response in this test system and is thus considered to be a non-sensitising substance. The sensitizing potential of benzophenone was determined in Guinea pigs according the Magnusson & Kligman method (1970). Sensitization was produced by intradermal injections and topical application at a 1 and 10% concentration and a challenge concentration of 1 and 5%. None of the 20 test animals showed a positive response. Therefore,	ECHA, 2014A

Endpoint	Description	Reference
	benzophenone is not subject to classification as a sensitizing substance. Benzophenone was tested in 25 human volunteers by the maximization test as published by Kligman (1966). The material was tested at a 6% concentration in petrolatum and produced no reactions.	
Subchronic/ repeated dose toxicity	Groups of 10 male and 10 female mice were fed diets containing 0, 1250, 2500, 5000, 10000, or 20000 ppm benzophenone for 14 weeks (male: 0, 200, 400, 800, 1600 or 3300 mg/kg bw/day; female: 0, 270, 540, 1000, 1900 or 4200 mg/kg bw/day). Animals were evaluated for clinical pathology, reproductive system effects, liver cytochrome P450 effects, and histopathology. Treatment-related increases in liver weights in all treatment groups were attributed to hypertrophy and/or cytoplasmic vacuolization of hepatocytes. Clinical chemistry analyses confirmed liver toxicity. Biochemical data indicated that benzophenone was a relatively potent inducer of the phenobarbital-type (2B) cytochrome P450 enzymes. A NOAEL for benzophenone was not achieved in this study. Groups of 10 male and 10 female rats were fed diets containing 0, 1,250, 2,500, 5,000, 10,000 or 20,000 ppm benzophenone for 14 weeks (male: 0, 75, 150, 300, 700 or 850 mg/kg bw/d; female: 0, 80, 160, 300, 700 or 1,000 mg/kg/day). Benzophenone was unpalatable at 20,000 ppm. All 20,000 ppm rats were terminated for humane reasons before the end of study. The liver and kidney were identified as target organs of benzophenone toxicity. Treatment-related increases in liver weights were attributed to hypertrophy and/or cytoplasmic vacuolization of hepatocytes. Increased kidney weights were associated with a spectrum of renal changes in exposed males and females. Clinical chemistry analyses confirmed liver toxicity. Biochemical data indicated that benzophenone was a relatively potent inducer of the phenobarbital-type (2B) cytochrome P450 enzymes. A NOAEL for benzophenone was not achieved in this study. Benzophenone was administered in the diet to rats at target dose levels of 20 mg/kg bw/day for 90 days and 100 or 500 mg/kg/day for 28 days. Body weights and food consumption were measured weekly; haematology, clinical chemistry and urinalysis values were obtained at 4 weeks and at the end of the study. Gross and microscopic pathological examinations were conducted and organ weights were recorded. Treatment-related changes occurred in erythrocyte count, haemoglobin, haematocrit, bilirubin, total protein and albumin at the mid- and high-dose levels, although all changes did not occur in both groups in both sexes. There were indications of increased absolute and relative liver and kidney weights in the mid- and high-dose groups, but this was not statistically consistent for absolute kidney weights. Histopathology of the liver in the mid- and high-dose groups showed hepatocellular enlargement with an associated clumping of cytoplasmic basophilic material around the central vein.	ECHA, 2014A

Endpoint	Description	Reference
	A no-effect level was demonstrated at 20 mg/kg/day for 90 days of administration. Dermal studies on carcinogenicity of benzophenone have been performed with female Swiss mice and New Zealand White rabbits. In lifetime studies, animals received twice-weekly topical administrations of 0.02 mL of 5%, 25%, or 50% benzophenone in acetone. Benzophenone was applied to a 1-inch square area on the dorsal skin between the flanks of mice; for rabbits, the dose was applied to the inside of the left ear. All mice died by week 110. The incidences of skin neoplasms in dosed mice were similar to those in the controls. Benzophenone had no effect on survival rates or on the incidences of neoplasms or non-neoplastic lesions in rabbits after 160 weeks of treatment. The negative results obtained with benzophenone in carcinogenicity studies by dermal application are in line with the presumed non-genotoxic mode of action of this compound, in view of the prevailing occurrence of genotoxic carcinogens among those active by topical application.	
Mutagenicity/ genotoxicity	*In vitro* methods: Benzophenone was tested in the Salmonella preincubation assay. The test was performed in duplicate with and without metabolic activation. Concurrent positive control substances confirmed the sensitivity of the test system. Benzophenone did not induce mutations in *S. typhimurium* strains in any of the concentrations tested and is therefore considered non-mutagenic in this test system. Benzophenone was tested by their differential growth inhibition in two *E. coli* cultures. No indication for DNA repair was detected. Thus, benzophenone was not mutagenic in this test system. Benzophenone was tested in a Mouse Lymphoma TK+- Assay. There was no positive response in mutant colonies. Therefore, benzophenone was not genotoxic in this test system. The WP2 mutagenicity test performed with strains WP2 uvrA/KM101 and IC203 is called the WP2 Mutoxitest. It has proved to be useful in preliminary validation assays designed to compare the sensitivity of strain IC203 with that of IC188 for the detection of mutagenesis by oxidants. Benzophenone did not induce an increase in the number of revertants and did thus not induce a mutagenic effect promoted by reactive oxygen. Benzophenone was tested in an Ames Test in *Salmonella* strains TA98, TA100, TA1535, TA1537 and TA1538. Five concentrations were selected from 20 to 2,000 µg/plate. Each dose was tested in triplicate with and without metabolic activation. Benzophenone did not induce a significant increase in revertant colonies and is thus considered non-mutagenic in this test system. The genotoxic potential of benzophenone and its metabolically related compounds, benzhydrol and p-benzoylphenol, was investigated using human cytochrome P450 enzymes. No induction of umu gene expression was observed *in Salmonella typhimurium* TA1535/pSK1002.	ECHA, 2014A

Endpoint	Description	Reference
	Human liver microsomes induced the bacterial cytotoxicty of these compounds without any umu gene expression. On the other hand, with the addition of *Escherichia coli* membranes expressing recombinant human P450 2A6 and NADPH-cytochrome P450 reductase (NPR), benzophenone showed umu gene expression. Activation of the metabolites was similar to that of benzophenone. The authors concluded that the genotoxic activity of benzophenone by human cytochrome P450s should be examined in terms of the risk to humans. *In vivo* methods: The *in vivo* genotoxic effect of benzophenone was determined using the flow cytometer-based micronucleus assay in mice (NMRI). No increase in the frequency of micronucleated polychromatic erythrocytes was found in the peripheral blood (fMNPCE). Only the mice and cells exposed to the positive controls, showed a significant increase in the mean fMNPCE, neither did the percentage of polychromatic erythrocytes,% PCE, show any change in the cell prolifieration. Benzophenone did not induce micronuclei in any of the doses (200, 300, 400 and 500 mg/kg) tested in male B6C3F1 mice and is therefore considered non-mutagenic in this test system.	
Carcinogenicity	2-year study in rats: Groups of 50 male and 50 female rats were fed diets containing 0, 312, 625, or 1,250 ppm benzophenone (equivalent to average daily doses of approximately 15, 30, and 60 mg benzophenone/kg bw to males and 15, 30, and 65 mg/kg bw to females) for 105 weeks. 2-year study in mice: Groups of 50 male and 50 female mice were fed diets containing 0, 312, 625, or 1,250 ppm benzophenone (equivalent to average daily doses of approximately 40, 80, and 160 mg/kg body weight to males and 35, 70, and 150 mg/kg kw to females) for 105 weeks. Under the conditions of these 2-year studies, there was some evidence of carcinogenic activity of benzophenone in male F344/N rats based on increased incidences of renal tubule adenoma; mononuclear cell leukemia in male F344/N rats may have been related to benzophenone exposure. There was equivocal evidence of carcinogenic activity of benzophenone in female F344/N rats based on the marginally increased incidences of mononuclear cell leukemia and histiocytic sarcoma. There was some evidence of carcinogenic activity of benzophenone in male B6C3F1 mice based on increased incidences of hepatocellular neoplasms, primarily adenoma. There was some evidence of carcinogenic activity of benzophenone in female B6C3F1 mice based on increased incidences of histiocytic sarcoma; the incidences of hepatocellular adenoma in female B6C3F1 mice may have been related to benzophenone exposure. Administration of benzophenone in feed resulted in increased incidences and/or severities of non-neoplastic lesions in the kidney and liver of male and female rats. and in the liver, kidney, nose, and spleen of male and female mice.	Chhabra, 2000

Endpoint	Description	Reference
	Decreased incidences of mammary gland fibroadenoma in female rats were related to benzophenone exposure.	
Reproductive toxicity	The reproductive toxicity of benzophenone was evaluated in a two generation test according to OECD 416, in which male and female Sprague-Dawley rats, parental (F0) and first generation (F1), were exposed to benzophenone by feeding diet containing benzophenone at concentrations of 0 (control), 100, 450 or 2,000 ppm. From the present study of benzophenone administered to rats over two successive generations, the no observed effect level (NOEL) on the parental animals is concluded to be less than 100 ppm (6.4 to 8.8 mg/kg bw/day). Concerning the reproductive toxicity in the parental animals, the NOEL is 2,000 ppm (130 to 179 mg/kg bw/day). In terms of the effects on the offspring, the NOEL is considered to be 450 ppm (5.6 to 15.5 mg/kg bw/day). A developmental toxicity study in rats was performed with benzophenone according to US EPA Guideline requirements, which widely complies with OECD 414. Pregnant rats were treated with the test item from Day 6 through 19 of pregnancy at daily dosages of 100, 200 and 300 mg/kg bw. Clear evidence of maternal toxicity (i.e., significant reductions in maternal corrected weight gain, and increased liver and kidney weights) was found at all doses in this study. Therefore, the maternal NOAEL was below 100 mg/kg bw/day. In the present study, mild effects on the developing foetal skeleton were observed at all doses (benzophenone exposure was associated with an increased incidence of unossified sternebra, a finding that is classified as a skeletal variation). A reduction of foetal body weight was found at the high dose. There was no increase in abnormalities/malformations in any of the doses tested. A developmental toxicity study in rabbits was performed with benzophenone according to US EPA Guideline requirements, which widely complies with OECD 414. Pregnant rabbits were treated with the test item from Day 6 through 29 of pregnancy at daily dosages of 5, 25 or 45 mg/kg bw. Maternal toxicity was noted at ~25 mg benzophenone/kg/day when administered by gavage on gestation-day 6 through 29. Evidence of maternal toxicity included a dose-related incidence of maternal mortality and early termination of pregnancy (i.e., abortion or early delivery), as well as reduced body weight, weight gain and feed consumption during late gestation. Developmental toxicity was seen at 45 mg/kg/day as reduced foetal body weight. There was no increase in abnormalities/malformations in any of the doses tested.	ECHA, 2014A
Other effects	No data.	

Endocrine disruption

Benzophenone is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014), but it is on the SIN list (SIN list database, 2014). Under REACH the substance is on the CoRAP list undergoing substance evaluation (start in 2013), but not with an initial concern for endocrine disruptive effects. If a concern for endocrine disruption arises during

evaluation of the data, it can lead to a request for more data to clarify the concern or a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH. This is expected to be resolved in 2015.

5.3.19 Benzophenone-12 (CAS No. 1843-05-6)

No harmonised classification. 484 notifiers out of 699 have suggested a classification as Skin Sens. 1 (H317), 5 suggested Skin sens 1B (H317), 3 suggested Eye Irrit. 2 (H319) and 27 suggested Skin Irrit. 2 (H315) (ECHA, 2014B). The substance is registered under REACH.

The summary is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

No data on absorption has been identified in the registration dossier. A worst case value of 10% will be used for the preliminary MOS calculation in accordance with the SCCS guidance (SCCS, 2012), as the MW > 500 and the log Kow > 7.6 for BP-12 (MW = 326.2; log Kow = 7.6).

A rather old (1968) study of the kinetics in male rats show a low oral absorption, excretion of the intact test substance mainly in the faeces with smaller amounts excreted in the urine conjugated to glucuronic acid but not to sulphate. No histopathologically affections of kidneys and liver were noted. Enterohepatic recirculation cannot be excluded (ECHA, 2014A).

The acute toxicity appears to be low with LD50 above 10,000 mg/kg determined in male rats by oral administration and by dermal administration to male albino rabbits (ECHA, 2014A).

Benzophenone-12 is not skin irritating and has only a slightly irritating effect on the eye of a transient nature not leading to permanent damage and is hence classified not irritating (ECHA, 2014A).

Sensitisation studies, all of high validity, provide conflicting results as two out of three studies all performed according to the same principles, the Guinea Pig maximisation test, show the test substance to be sensitising and one not (ECHA, 2014A).

Four pivotal studies with repeated dose oral administration, two in rats (28 and 90 days duration) and two old studies in dogs (4 and 24 months), were found. The toxicity in rats appears to be moderate to low with the kidney and the thyroid as target organs. In dogs benzophenone-12 appear to be slightly more toxic as the intermediate dose could be appointed the NOAEL whereas in the rat the high dose was the NOAEL. This is however dependent on the basis for selection of the dose levels. The liver is the target organ in dogs (ECHA, 2014A).

Mutagenicity have been assayed *in vitro* in several bacterial reverse mutation assays, in chromosome aberration assay in human lymphocytes and Chinese Hamster Ovary cells and in a mouse lymphoma test; all showing no mutagenic effect (ECHA, 2014A).

Effect on reproduction have been investigated in a rather unconventional study type, a four generation study in SD rats integrating nearly all of the elements from fertility and teratology studies showing no effect on any of the many parameters determined at a dose level of 6,000 ppm (approx. 524 mg/kg/day) administered in four successive generations (ECHA, 2014A).

Specific investigations on nephrotoxicity have been performed. For unknown reasons though, urinalysis was not performed in the repeated dose studies why this affection apparently have not

been intercepted. Haematuria, proteinuria and crystalluria appear to be a result of treatment with benzophenone in rats with a NOAEL considered to 6,000 ppm (ECHA, 2014A).

TABLE 62
HEALTH PROPERTIES OF BENZOPHENONE-12 (CAS NO. 1843-05-6)

Endpoint	Description	Reference
Benzophenone-12 (CAS No. 1843-05-6)		
Toxicokinetics	In a 35 day feeding study in male rats (1.25 and 5%, 230 to 287 mg/day and 850 to 1112 mg/day), urine samples were obtained at day 11, 22 and 35. Kidneys, liver, faeces and urine was investigated. The oral absorption was low (though not specified), Excretion is mainly in the faeces of unchanged test substance. In urine the glucuronide, but not the sulphate conjugate, was found. Enterohepatic recirculation cannot be excluded though histopathology shows no affections of liver or kidneys.	ECHA, 2014A
Acute toxicity	Acute oral toxicity in male rats was determined in an old study (OECD TG 423 performed in 1965) without many details to LD50 above 10,000 mg/kg. Groups of 10 rats received by gavage a 20% solution. No affection of body weight-gain. Macroscopic necropsy showed no findings. Considered 'practically nontoxic' by the applicant. Acute dermal toxicity in male rabbits was determined also in an old study (OECD TG 402 performed in 1965) without many details though occlusive or semi occlusive to LD50 above 10,000 mg/kg. Neither clinical signs nor macroscopic necropsy revealed any findings.	ECHA, 2014A
Irritation and corrosivity	Skin irritation determined on 3 NWZ male rabbits (OECD TG 404) using 0.5 g/site with intact and abraded skin under occlusion and a residence time of 4 hours showed a score of 0 both on erythema and edema why the test substance is non-irritating. Eye irritation determined on 3 NWZ male rabbits (OECD TG 405) with 0.1 g/eye (both eyes treated; one washed immediately after treatment one not) showed a slight increase in iris score, chemosis score and conjunctiva score but not cornea score, however fully reversible after 72 hours. The test substance is classified as not eye irritating.	ECHA, 2014A
Skin sensitisation	Three studies all performed according to the same OECD TG 406, Guinea pig maximisation test, provide conflicting results as two studies detect a sensitisation to be present and one study have not detected any sensitisation. A potential for sensitisation is evident.	ECHA, 2014A
Subchronic/ repeated dose toxicity	Benzophenone-12 was studied in a 90 day, oral (diet) study (OECD TG 408) comprising 10 males and 10 females, newly weaned, per group, received in the diet 0, 650, 1,000 or 1,500 ppm. No changes were observed wrt:. clinical signs, body weight and body weight-gain, food consumption, food efficiency, haematology and clinical chemistry, organ weight and gross and histopathology. Water consumption, ophthalmoscopy, urinalysis and neurobehavior was not investigated. Only finding was slight relative increase in kidney weight in high dose females and slight relative increased thyroid weight in	ECHA, 2014A

Endpoint	Description	Reference
	intermediate and high dose males though not confirmed by alterations in histopathology hence considered not treatment related. NOAEL above 1500 ppm. Benzophenone-12 was studied for oral toxicity in SD rats in a 28-day repeat dose toxicity test (OECD TG 407) at doses of 0, 20, 140, and 1,000 mg/kg/day given to groups of 6 males and 6 females. Two weeks of recovery was included. No test substance-related changes were noted in terms of clinical observation, body weight and body weight-gain, food consumption, haematology, clinical chemistry, urinalysis, gross and histopathology. Ophthalmoscopy and neurobehavior was not investigated. NOEL considered to be 1,000 mg/kg/day for both sexes. Benzophenone-12 was studied in an old study in Beagle dogs (OECD TG 409, performed in 1965). Groups of 2 males and 2 females received daily, for 124-127 days, in the diet 0, 2,000, 6,000 or 18,000 ppm, 18,000 ppm reduced to 4,000 after two weeks due to unpalatibility. No test substance related changes were observed wrt. clinical signs, body weight and body weight-gain, food consumption, haematology and clinical chemistry, ross and histopathology. Food efficiency, ophthalmoscopy, urinalysis and neurobehavior was not investigated. NOAEL above 6,000 ppm. Benzophenone-12 was studied in an old study in Beagle dogs (OECD TG 452, performed in 1966-69). Groups of 4 males and 4 females received daily for two years in the diet 0, 1,000, 3,000 or 9,000 ppm (approx. 0, 33, 100 or 300 mg/kg). No test substance related changes were seen wrt. clinical signs. Body weight-gain was decreased in high dose. Food consumption and hereby dose level was variable in particular in the high dose group. Haematology showed reduced leucocyte count after one year of administration in high dose males. Clinical chemistry showed increased alkaline phosphatase in high dose group females. Histopathology showed centri-lobular inflammation in the liver of high dose females. NOAEL 3,000 ppm (approx. 100 mg/kg). Four other studies, all in rats but of dubious validity (hence not further mentioned), have been found. They provide no information altering the above provided observations and conclusions. Possible nephrotoxicity was investigated in three studies. In a study with three sessions in SD rats (4m +4f, 3m + 3f, 2m + 2f) with a duration of 35, 25 or 20 days with administration in the feed (0, 6,000 or 18,000 ppm). The urine was monitored daily for haematuria, occult blood, proteinuria or crystalluria. The urinary system of all animals appeared normal at gross autopsy. Microscopically all exposed animals revealed the same type of histopathology but to varying degrees, with the 6,000 ppm animals revealing these changes to a milder degree than the 18,000 rats. Specifically, the lesions were found at the glomerular level and at the convoluted tubular level (with the results of these lesions seen all the way down through the collecting tubules, renal pelvis, ureter and bladder). The glomerular lesions consisted of varying degrees of roughening of	

Endpoint	Description	Reference
	the glomerular capillary membrane with several of the glomeruli exhibiting RBC diapedesis and frequent proteinaceous casts within Bowman's capsule. The convoluted tubules exhibited varying degrees of cloudy swelling with casts within the lumen consisting of what appeared to be sloughed-off sections of the cytoplasm of the lining cells. Free RBCs were seen in the collecting tubules, in the renal pelvis and in the lumen of the bladder. Specifically within the lumen of the bladder spherical shattered-glass-like crystals were seen exhibiting a radial arrangement with many RBC's meshed within, particularly so at the periphery. These crystals were similar to the ones seen in the urine during routine microscopic examination. In a follow up study with 4 male rats treated for 21 days, one lower dose was assayed under similar circumstances, 2,000 ppm in a group of 4 males and 4 females together with a repetition of the two other dose levels which showed similar changes as in the first study. 1) Base-line urine analysis All base-line urinalyses were normal for all rats for one week prior to initiation of dosing 2) Control group Occult blood was observed each once in 2 rats, microscopic haematuria each once in 3 rats, microscopic proteinuria in 2 animals (respectively three times and once), crystalluria once in 1 rat. 3) 2,000 ppm dose group Occult blood was observed once in 1 rat, microscopic haematuria once in 1 rat, microscopic proteinuria in 3 animals (once, twice and three times, respectively), crystalluria three times in 1 rat. 4) 6,000 ppm dose group Occult blood was observed each once in 3 rats, microscopic haematuria each once in 2 rats, microscopic proteinuria in 0 animal, crystalluria in 3 rats (five times and each once, respectively). 5) 18,000 ppm dose group All four animals on occasions exhibited microscopic haematuria, proteinuria, crystalluria and occult blood. This study was repeated with a similar result. Apparently the NOAEL for nephrotoxicity is 6,000 ppm.	
Mutagenicity/ genotoxicity	Ames' test, bacterial reverse mutation (OECD TG 471) fully compliant with the guideline showed no mutagenicity of benzophenone-12. *In vitro* Mammalian Chromosome Aberration Test, (OECD TG 473) performed in human lymphocytes was fully compliant with the guideline and showed no mutagenic effect. Four other studies, one chromosome aberration test in Chinese Hamster Ovary cells, three bacterial reverse mutation tests with a reduced number of strains used and a mouse lymphoma test confirmed the absence of a mutagenic effect of benzophenone-12.	ECHA, 2014A
Carcinogenicity	No data	
Reproductive toxicity	In a fairly unconventional study, four generation study in rats, benzophenone-12 was given in the feed (0 or 6,000 ppm –approx.	

Endpoint	Description	Reference
	524 mg/kg/day) throughout four generations of SD rats. Neither clinical signs, body weight, body weight-gain, reproductive performance, viability of the offspring, sexual maturation, organ weight, histopathology, abnormalities/malformations nor the various fertility indices showed any meaningful difference between controls and treated animals. NOAEL both for fertility and developmental toxicity 6,000 ppm (approx. 524 mg/kg/day).	
Other effects	Potential endocrinedisruptive effects not evaluated by Axelstad et al. (2013)	Axelstad et al., 2013

Endocrine disruption
Benzophenone-12 is not on the European Commission priority list of potential endocrine disruptors (EU COM database, 2014) or on the SIN list (SIN list database, 2014). Under REACH the substance is on the CoRAP list and will undergo substance evaluation (in 2015), with an initial concern for endocrine disruptive effects. This can lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH or a conclusion that the available data are adequate to conclude that the substance is not of concern. This is expected to be resolved in 2016.

5.4 Conclusions

A hazard assessment has been carried out for the 19 substances selected based on one or more of the following criteria as presented in section 3.3:

- presence in cosmetics identified by shop survey – in particular sun products
- occurrence in human urine or breast milk
- occurrence in drinking water
- presence in the aquatic environment or biota
- potential endocrine disrupting properties
- the exposure from cosmetics evaluated as high
- presence in other product groups with direct or potentially high exposure (textiles, paints, food packaging).

The hazard ssessment has more the character of a screening of data than a full assessment. Where no scientific opinions or other peer reviewed evaluations of the substances have been identified, data retrieved from the publicly accessible summaries of the confidential REACH registration dossiers on ECHAs homepage have been used including NOAELs suggested by the registrant. It is therefore important to note that the data used in the hazard assessments have not undergone a detailed validation as part of this project. In Table 63 results from the health hazard assessment of the selected substances are presented as input to the risk assessment. The following data have been included in the table:

- Harmonised classifications or industry-suggested classifications for the substances where available. As indicated by classifications for the approved UV filters, most of the substances do not have a health classification, whereas a few have a classification reflecting irritative properties. In addition, BP-3 has an industry-suggested classification with specific target organ toxicitiy following a single exposure as it is also the case for BP and BP-1 which are not approved as UV filters in cosmetics. Approximately 10% of the notifiers have suggested Repr. 2 (H361) for 4-MBC.

- A column showing the evaluation of the status for the diffent substances regarding potential endocrine disruption.
- A column showing the critical effect of the substance and the background for the suggested NOAEL value.
- A column showing the NOAELs selected for risk assessment. NOAELs suggested for the risk assessment are in the range of 20 – 1000 mg/kg bw/day. The lowest value of 20 mg/kg bw/day is suggested for BP.
- A column showing the dermal absorption ratio to be used for the preliminary MOS calculation.

TABLE 63
SUMMARY OF ASSESSMENT OF HEALTH HAZARD

Substance (UV=approved UV filter)	Classification	Health hazards		NOAEL O: oral D: dermal	Dermal absorbtion to be used in MOS calculation ** %
	H: Harmonised N: Notified*	Potential endocrine disruption	Critical effects		
Benzophenone-3 (BP-3) (CAS No. 131-57-7) (UV)	N: Skin Irrit. 2 (H315): 827/1152 Eye Irrit. 2 (H319): 827/1152 STOT SE 3 (H335): 89/1152	Suspected endocrine disruptor	Maternal and developmental toxicity	O: 200 mg/kg bw/day	10% (sunscreens) 8% (other products)
Octocrylene (OC) (CAS No. 6197-30-4) (UV)	N: No health classification suggested	Suspected endocrine disruptor	Haematology, clinical chemistry, organ weight gain, and pathology, etc.	O: 175 mg/kg bw/day	10%
Benzophenone-1 (BP-1) (CAS No. 131-56-6)	N: Skin Irrit. 2 (H315): 827/1179 Eye Irrit. 2 (H319): 973/1179 STOT SE 3 (H335): 823/1179 Skin sens. 1 (H317): 93/1179	Suspected endocrine disruptor	Repeated dose toxicity, not further defined	O: 236 mg/kg bw/day	100%
*4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9) (UV)	N: Repr. 2 (H361): 23/271	Suspected endocrine disruptor	Repeated dose: thyroid effects	O: 25 mg/kg bw/day D: 400 mg/kg bw/day	1.1%
2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3) (UV)	N: No health classification suggested	Not enough data to conclude	Pigmentation of spleen	O: 100 mg/kg bw/day	11.6%

Substance (UV=approved UV filter)	Classification	Health hazards		NOAEL O: oral D: dermal	Dermal absorbtion to be used in MOS calculation ** %
	H: Harmonised N: Notified*	Potential endocrine disruption	Critical effects		
Titanium dioxide (CAS No. 13463-67-7) (UV)	N: No health classification suggested	Not enough data to conclude	No dermal penetration	Not assigned	No absorption
Butyl methoxy-dibenzoylmethane (BMDBM) (CAS No. 70356-09-1) (UV)	N: No health classification suggested	Not enough data to conclude	Haematology, clinical chemistry, organ weights and non-neoplastic histopathology	O: 450 mg/kg bw/day	10%
Ethylhexyl salicylate (CAS No. 118-60-5) (UV)	N: Skin Irrit. 2 (H315): 878/894 No classification: 12/894	Not enough data to conclude	Systemic toxicity	O: 250 mg/kg bw/day	0.5%
Ethylhexyl triazone (CAS No. 88122-99-0) (UV)	H: No health classification, env. clasification	Not enough data to conclude	Maternal and embryotoxicity	O: 1,000 mg/kg bw/day	10%
Bis-ethylhexyloxyphenol methoxyphenyl triazin (CAS No. 187393-00-6) (UV)	N: No notifications	Not enough data to conclude	Systemic toxicity	O: 1,000 mg/kg bw/day	10%
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7) (UV)	H: No health classification, env. classification	Not enough data to conclude	Developmental and reproductive effects	O: 100 mg/kg bw/day	0.5%
Diethylhexyl butamido triazone (CAS No. 154702-15-5) (UV)	N: No health classification suggested	Not enough data to conclude	No effectts at highest dose level tested	O: 831 mg/kg bw/day	10%
Ethylhexyl methoxy-cinnamate (OMC) (CAS No. 5466-77-3) (UV)	N: No health classification suggested	Suspected endocrine disruptor	Organ weights, non-neoplastic histopathology, parental toxicity, fertility and reproductive parameters, and developmental toxicity.	O: 450 mg/kg bw/day	10%
Homosalate (CAS No. 118-56-9) (UV)	N: No health classification suggested	Not enough data to conclude	Systemic toxicity	O: 100 mg/kg bw/day	2%
Drometrizol trisiloxane (CAS No. 155633-54-8) (UV)	N: no notifications	Not enough data to conclude	Photoallergy	No data	No data

Substance (UV=approved UV filter)	Classification	Health hazards		NOAEL O: oral D: dermal	Dermal absorbtion to be used in MOS calculation ** %
	H: Harmonised N: Notified*	Potential endocrine disruption	Critical effects		
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7) (UV)	H: Eye Dam. category 1 (H318)	Not enough data to conclude	Systemic toxicity, thyroid effects	O: 300 mg/kg bw/day	0.16%
Isoamyl p-methoxy cinnamate (CAS No. 71617-10-2) (UV)	N: No health classification suggested	Suspected endocrine disruptor	Body weight, haematology, clinical chemistry and organ weights	O: 200 mg/kg bw/day	10%
Benzophenone (BP) (CAS No. 119-61-9)	N: STOT RE 2 (H373): 935/2706 Skin Irrit. 2 (H315):247/2706 Eye Irrit. 2 (H319): 212/2706 STOT SE 3 (H335): 140/2706 Acute tox. 4 (H302): 11/2706 Carc. 2 (H351): 1/2706	Suspected endocrine disruptor	Liver and kidney effects	O: 20 mg/kg bw/day	70%
Benzophenone-12 (CAS No. 1843-05-6)	Skin Sens. 1 (H317): 484/699 Skin Irrit. 2 (H315): 27/699 Skin Sens. 1B (H317): 5/699	Suspected endocrine disruptor	Systemic toxicity	O: 100 mg/kg bw/day	10%

* Notified classification as suggested by most notifiers. Figures will not always add up to the total, as classifycation for physical hazards and environmental classifications are not mentioned. The figures indicate number of notifiers suggesting the classification / total number of notifiers.
**Dermal absorption is based on experimental studies where available, Where no information is available a worst case dermal absorption of 100% is used. If the MW of the substance is > 500, and log Pow is <-1 or >4, the value of 10% dermal absorption is used according to the SCCS guide (SCCS, 2012). Information regarding MW of the selected substances is taken from ACToR (Aggregated Computational Toxicology Resource) from the US EPA via the OECD eChemPortal34.

[34] http://www.echemportal.org/echemportal/page.action?pageID=9

6. Exposure and risk assessment – health

6.1 Objective of exposure and risk assessment

Together with results from the survey and hazard assessment providing information on the presence of UV filters and absorbers in consumer products and their related hazards, the objective of the exposure and risk assessment is to provide some information regarding the combined consumer exposure and potential risks that need to be further addressed.

6.1.1 Methodology for exposure and risk assessment

Assessment of exposure and systemic risk from use of cosmetic products is carried out in accordance with the principles outlined in the SCCS's "Notes of Guidance for the Testing of Cosmetic substances and their Safety Evaluation" (SCCS, 2012). Where opinions from the SCCS are available for the substances, these are included in the assessments. For the UV absorber BP-1 which was found in nail polish, and for BP which is registered under REACH for use in e.g. perfume but not allowed as a UV filter in sunscreen products, default exposure values recommended by the Nordic Council of Ministers (Nordic Council of Ministers, 2012) have been applied in the risk assessment. When cosmetic products are not the only source of exposure to an ingredient and significant exposure is caused by other sources (e.g. consumer products, food, environment), the SCCS recommends basing the quantitative risk assessment upon aggregate exposure.

The exposure from the use of UV filters in cosmetics is calculated based on the maximum allowed concentrations for the filters. The exposure from UV absorbers (not allowed as UV filters in sunscreen products) will be calculated based on information from market actors or the literature about typical concentration levels for UV absorbers.

For product types other than cosmetics, the risk is normally characterised based on a Derived No Effect Level (DNEL) and calculation of a risk characterisation ratio is carried out in accordance with REACH guidance documents issued by ECHA. In the present project only MOS values are calculated in accordance with the tender document; therefore, calculation of aggregate exposure from use of UV absorbers in various cosmetic product types is also included. This calculation is based on an aggregate exposure of 17.4 g/day corresponding to the global daily exposure estimated for preservatives used in all cosmetics. The calculation is expected to grossly overestimate the actual risk, in particular for substances with limited use. It is, however, included to provide a worst case scenario for use of the substances in cosmetics and to provide perspective to an evaluation of how much room is left for other exposures through different consumer products, drinking water and the environment. If this calculation does not trigger a concern for risk, the possible combined exposure from cosmetics and other sources is also less likely to result in unacceptable risk.

Thus, the selected exposure scenarios reflect exposure to the substances from daily application of sunscreen products to the whole body, and a more unrealistic aggregate daily exposure reflecting use of the UV substances in different cosmetic products applied to different parts of the body. The latter is included as a alternative to calculating an aggregate exposure and risk based on all potential exposures from different sources, which would require more detailed information on the uses and exposure situation.

Sixteen out of the 19 UV filters and absorbers selected for exposure and risk assessment are identified in the different cosmetic products and 15 of these substances are also found in sunscreen products (lotion/cream/oil/mist) as part of the survey carried out in 11 different shops. Of these substances, 6 are found in lip balm with a potential for oral exposure. Among the 15 UV filters found in sunscreens, 5 are registered under REACH for use in product types other than cosmetics and 3 are identified in other product types as part of the market survey. The 3 substances included ethylhexyl dimethyl PABA (OD-PABA) which was found in the group of paints, lacquers, adhesives and sealants, and in printing inks; and titanium dioxide and butyl methoxydibenzoylmethan (BMDBM), which were found in toys. For details about the individual substances reference is made to Chapter 2**Fejl! Henvisningskilde ikke fundet.** and Table 20.

It should also be stressed that although the substances have not been found in a particular product type as part of the market survey carried out in relation to this project, it cannot be excluded that these substances are present on the Danish market. As an example, UV filters and absorbers have not been identified in washing and cleaning products as part of the survey although this scenario was expected based on product information on the internet. On the other hand, it should also be noted that although a substance is registered under REACH for a particular use, it does not mean that it actually is available for that use on the market. It is therefore not possible, based on the present survey, to draw a complete picture of the potential exposure to the substances selected for exposure and risk assessment.

Five of the 19 substances (BP-3, OC, 4-MBC, OD-PABA and OMC) have been identified in the literature in biomonitoring studies, in drinking water (surface water), and in biota or the aquatic environment. HMS has been identified in biomonitoring studies and in biota and the aquatic environment, BMDBM has been identified in biota and the aquatic environment, and BP in drinking water. In Denmark BP-3, 4-MBC and OMC have been detected in biomonitoring studies, whereas other findings are reported from different European countries and the USA.

It is assumed that all of the substances in question are available for uptake. Where no information on dermal absorption is available, and no expert judgment can be made, the exposure scenarios assume 100% dermal uptake as a worst case, except in the cases where the molecular weight (MW) is higher than 500 Da and log P_{ow} is smaller than -1 or higher than 4. In these cases, a dermal absorption of 10% will be used in accordance with the SCCS Notes of Guidance (SCCS, 2012). Information regarding MW of the selected substances is taken from ACToR (Aggregated Computational Toxicology Resource) from the US EPA via the OECD eChemPortal[35]. If the calculated margin of safety (MOS) is less than 100, this implies a risk for the consumer and the result is discussed in relation to the assumptions made.

With regard to application methods for the cosmetic products identified as part of the shop survey, 15 substances are found in pump sprays, 8 substances in trigger sprays and 7 substances in pressurised aerosol sprays. Only pressurised aerosol sprays are expected to produce larger fractions of aerosols in the respirable range, whereas trigger sprays and pump sprays primarily produce droplets in the non-respirable range (particles with aerodynamic diameter >10 μm). Larger particles which are exhaled may be swallowed. The Cosmetic Ingredients Review (CIR) Expert Panel has issued a document on aerosols (CIR, 2012), describing the typical particles released from a pump spray. According to CIR (2012), the median d_{ae} of the airborne droplets / particles of pump hair sprays range from 60 μm to 80 μm and typically less than 1% of the airborne droplets/particles released from pump sprays are in the range considered to be respirable (i.e. d_{ae} <10 μm). Droplets/particles with d_{ae} >15 μm are expected to be deposited almost exclusively in the nasopharyngeal and bronchial regions of the respiratory tract, from where particles with d_{ae} >7 μm are typically cleared within 24 hours in healthy individuals through mucociliary action (CIR, 2012).

[35] http://www.echemportal.org/echemportal/page.action?pageID=9

In comparison, the median d_{ae} of the airborne droplets/particles of propellant hair sprays are mentioned to range from 25 µm to 50 µm. The CIR Expert panel also states that usually 1% to 2.5% but no more than 5% of the droplets/particles emitted from propellant hair sprays are within the respirable range. As the liquid product in sunscreen aerosol sprays is expected to be more viscous than hair spray, realistically, sunscreen aerosols should not release more particles than hairspray in the respirable range.

The maximum allowed concentration of UV filters in cosmetics is generally higher than the concentration used in other product types according to results of the survey. For the exposure scenarios, the concentration used in sunscreen products is therefore selected as a worst case scenario for the risk assessment. When sunscreen products are used, it is expected that other creams/lotions would not be used at the same time. If the worst case scenarios indicate a concern for safety, the result will be discussed based on more realistic assumptions. No information has been identified regarding migration of the substances from articles; exposure based on migration from e.g. textiles or polymeric materials is therefore not quantified.

Exposure parameters relevant for the exposure scenarios are shown in Table 64.

TABLE 64
OVERVIEW OF EXPOSURE PARAMETERS RELEVANT FOR DERMAL EXPOSURE

Descriptor	Input parameter
Exposed person	Adult (female)
Body weight	Adult (female): 60 kg
Amount of sunscreen applied per day	18,000 mg /36,000 mg per day
Aggregate amount of cosmetic products for skin care and makeup	17,400 mg per day
Absorption through skin	100% if no data and $-1 < \log P_{ow} < 4$, or 10 % if MW> 500 and $\log P_{ow} < -1$ or > 4, or as specified for the substance in the literature, or expert judgment
C (Concentration of the substance in the cosmetic product)	Maximum allowed concentration as UV filter (worst case), or as specified for the substance by market actors
SED (Systemic Exposure Dosage)	SED=A (mg/kg bw/day) × C (%)/100 × DA_p (%)/100
MOS (Margin of safety)	NO(A)EL/SED

With regard to amount of sunscreen applied dermally, the exposure assessment considers both application of 18 g/day as recommended by SCCS (2012) as a realistic exposure scenario and 36 g/day as mentioned in the preamble of the Commission Recommendation on the efficacy of sunscreen products and the claims made relating thereto[36].

Total systemic exposure from daily use of different cosmetic product types is in principle calculated as:

$$SED_{tot} = SED_{inhal} + SED_{dermal} + SED_{oral}$$

based on the estimated daily exposure levels as outlined in the SCCS guidance (SCCS, 2012).

[36] Commission Recommendation 2006/647/EC of 22 September 2006 on the efficacy of sunscreen products and the claims made relating thereto.

The significance of exposures related to other product types is discussed primarily in a qualitative way, and is only quantified if relevant data are available.

6.2 Risk assessment

Risk assessment is carried out based on the standardised exposure scenarios for sunscreens and for aggregate exposure from various cosmetic products. Other expected contributions from different identified sources are discussed in this context.

Some of the UV-filters are suspected endocrine disruptors. When this is the case, it introduces some uncertainty into the risk assessment, since it is still discussed whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty (Hass et al., 2013). There are currently no internationally accepted criteria for the identification of endocrine disruptors, and none of the substances have been identified as endocrine disruptors under REACH (article 57(f)) in a case-by-case evaluation. Therefore, the uncertainty regarding the risk arising from potential endocrine disruptive properties is described qualitatively, and the process for further assessment of potential endocrine disruptive effects is described. In general it can be concluded that all UV filters that are suspected endocrine disruptors are undergoing substance evaluation or risk management option analysis under REACH, in which their potential endocrine disruptive properties are investigated further. It should also be mentioned that the scientific committee for consumer safety (SCCS), which carries out risk assessments for substances in cosmetics and advises the EU Commission, has concluded the following in its Memorandum on Endocrine Disruptors (SCCS/1544/14): "EDs can therefore be treated like most other substances of concern for human health and the environment, i.e. be subject to risk assessment and not only to hazard assessment". This means that identified endocrine disruptors can currently be regulated in cosmetic products even without internationally accepted criteria for the identification.

The risk assessment follows the principles outlined in the SCCS's Notes of Guidance (SCCS, 2012) and is based on a calculation of the Margin of Safety (MOS) and the following equation:

$$MOS = \frac{\mathrm{NO(A)EL}}{\mathrm{SED}}$$

The calculated MOS is in the final stage rounded to two significant figures in line with recommendations from the EFSA Scientific Committee regarding derived, health based guidance values (EFSA, 2012).

The Margin of Safety (MOS), like the Margin of Exposure, expresses the ratio between the No Observed Adverse Effects level (NOAEL) (or NOEL in the absence of a NOAEL) for the critical effect and the theoretical, predicted, or estimated exposure dose or concentration, and it is generally accepted that MOS should be at least 100 to conclude that a substance is safe for use according to WHO and the SCCS guidance document.

SED (in mg/kg bw/day) is the systemic exposure dosage of the substance calculated as a percentage of the amount of substance applied (in mg/kg bw/day) as follows:

$$SED = A_{bw}\left[\frac{mg}{kg\ bw\ \times\ day}\right] \times C[\%]/100 \times DA_p[\%]/100$$

A_{bw} (mg/kg bw/day) = Estimated daily exposure to a cosmetic product per kg body weight
C (%) = Concentration of the substance in the finished cosmetic product expressed as a percentage
DA_p (%) = Dermal Absorption expressed as a percentage
bw (kg) = Body weight

As part of the calculation, the total amount of active ingredient applied ($V_i = A \times C$) and total amount absorbed ($A = V \times DA_p$) are calculated as intermediate results.

6.2.1 Benzophenone-3 (Oxybenzone) (BP-3) (CAS No. 131-57-7)

Basis for MOS calculation

The hazard assessment summary presented in section 5.3.1 is solely based on the SCCP (2006, 2008) opinions. The information is considered as being sufficient for the safety assessment of benzophenone-3 as a UV filter in cosmetic products.

In an *in vitro* dermal absorption study, the mean dermal absorption was 3.1% of the applied dose for a sunscreen containing the maximum requested benzophenone-3 concentration of 6% and 4.0% of the applied dose for a sunscreen (o/w or w/o) containing a benzophenone-3 concentration of 2% (SCCP, 2008a). The SCCP used the mean value plus 2 standard deviations, i.e. a dermal absorption of 9.9% (6% formulation) and 8.0% (2% formulation) for the MOS calculation (SCCP, 2008a). The authors of this report agree with the evaluation of the SCCP; a dermal absorption of 10% is used for the MOS calculation for use of benzophenone-3 in sunscreens and of 8% for other cosmetic formulations.

Based on the oral and dermal subchronic repeated dose toxicity studies performed in rats and mice, a NOAEL of 411 and 200 mg/kg bw/day, respectively, was concluded by the submission authors (SCCP, 2006). The SCCP did not conclude on a NOAEL for the oral and dermal subchronic repeated dose toxicity studies. As the original study reports have not been available to the authors of this report, an evaluation of the suggested NOAELs cannot be performed. Based on a well-described teratogenicity study in rats, a NOAEL for maternal and developmental toxicity of 200 mg/kg bw/day was determined (SCCP 2006) and the SCCP used this NOAEL for the calculation of the MOS (SCCP 2008). The authors of this report agree with the evaluation of the SCCP; a NOAEL of 200 mg/kg bw/day will be used for the MOS calculation.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), benzophenone-3 is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations. For use in sunscreens, the MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = A x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A= Q_i x DA_p	=	180 mg/day
Systemic exposure dose (SED)	180/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (teratogenicity study, maternal effects, oral, rat)		=	200 mg/kg bw/day
MOS	NOAEL/SED	=	67 (< 100)

It should be noted that the dermal absorption of 10% stems from an *in vitro* dermal absorption study using a sunscreen containing the maximum amount requested by the applicant of 6% (SCCP, 2008a), not the maximum amount of 10% as allowed according to the Cosmetics Regulation (EU Regulation 1223/2009). The dermal absorption from a sunscreen containing 10% benzophenone-3 could be higher from that of a sunscreen containing 6% benzophenone-3. However, the difference in dermal absorption of benzophenone-3 from a 6% and a 2% sunscreen was not considerable, i.e. 9.9 and 8.0%, respectively.

It should also be noted that a MOS of 112 was calculated in the SCCP opinion (SCCP, 2008a) based on the maximum amount requested by the applicant of 6%.

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 33 (< 100).

MOS calculation for application in other cosmetic products

In the shop survey, the substance was found in 17 out of 291 products. Of these, 4 products were sunscreen products and 5 products were face creams. Other products included eau de toilette, foundation, handcream, lip balm and eye cream. According to the SCCP opinion (SCCP, 2008a) benzophenone-3 can also be used as a UV absorber at 0.5% to protect cosmetic formulations against sunlight. This concentration is based on market information and not restrictions in the regulation. The MOS calculations for use of benzophenone-3 in these cosmetics are performed with this concentration, i.e. 0.5%. The amount of cosmetic product applied daily is set at 17.79 g/day for all cosmetic products, in accordance with the SCCP opinion for benzophenone-3 (SCCP, 2008a):

Amount of cosmetic product applied daily	(A)	=	17,790 mg/day
Concentration of ingredient in finished product (C)		=	0.5%
Total amount of active ingredient applied	(Q_i) = A x C	=	89 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	8%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	7.2 mg/day
Systemic exposure dose (SED)	7.2/60	=	0.12 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (teratogenicity study, maternal effects, oral, rat)		=	200 mg/kg bw/day
MOS	NOAEL/SED	=	1700

Use in other products

As part of the market survey, the substance has been identified in plastics, paints, varnishes, adhesives and sealants, and food packaging.

Benzophenone-3 is registered under REACH for use in cosmetic and personal care products, coatings, paints, thinners, paint removers, fillers, putties, plasters, modelling clay, and finger paints. The volume registered under REACH is in the lower tonnage band (10-100 tonnes). The total amount registered in the Danish Product Register was 1.1 tonnes in 2011 under the use category paints, varnishes and printing ink.

Total exposure

The results of the survey indicate that use in cosmetics is not a major source of exposure to BP-3 as it is only identified in approximately 6 % of the surveyed products. The substance was found in both sunscreen and other cosmetic products which may be used all year around. However, if BP-3 as indicated is being replaced by other UV-filters in sunscreens, this is likely to reduce exposure during summertime. Direct exposure may in addition be possible from mixtures like paints, varnishes, adhesives and sealants and from migration to food. Typical concentrations of UV filters and absorbers in paint type products are reported to be around 0.1%, which is one hundredth of the maximum allowed concentration as a UV filter in cosmetics. Even assuming in a worst case scenario that other product types are used on a daily basis, the actual amount of product in contact with the body is expected to be significantly lower than the estimated amounts of cosmetic products.

Exposure from migration of the substances from coatings or polymeric materials is also considered possible. However, no information regarding migration has been identified. Furniture, surfaces and articles coated with e.g. paints and varnishes may release small amounts of the substances to the indoor environment, e.g. dust which can be inhaled and ingested.

BP-3 has furthermore been found in drinking water (from surface water) in different European countries, but it is not known if this is also the case in Denmark.

BP-3 has also been measured in the environment and in biomonitoring studies in different countries, including Denmark, and not only during the summer. These results indicate that there may be sources of exposure other than sunscreens.

Conclusion
The use of benzophenone-3 as a UV filter at the maximum amount of 10% in sunscreens as allowed according to the Cosmetics Regulation (EU Regulation 1223/2009) can pose a risk for the consumer (MOS = 67). However, the results of the survey indicate that BP-3 is not a common UV filter in cosmetics in Denmark. Furthermore, a calculation based on the maximum concentration of 6% as requested by the applicant (SCCP, 2008a) would result in a MOS >100 (MOS = 112).

The use of benzophenone-3 as a UV filter of up to 6% in sunscreens and up to 0.5% in other types of cosmetic products to protect the formulation against sunlight is not expected to pose a risk for the consumer (MOS > 100 in both cases), except for its contact allergenic and photoallergenic potential.

It has not been possible to quantify all sources of BP-3 exposures, but in total they are expected to be considerably lower on a daily basis than what is reflected by the worst case calculation of the the exposure from cosmetics.

BP-3 has been identified in biomonitoring studies in the winter months as well, and it has been measured in drinking water (surface water) in other European countries and in the environment, indicating exposure of consumers occurring not only from sunscreen products. It is not possible to conclude whether exposure in the wintertime is occurring from other cosmetic products or from other product types.

Human health effects from BP-3 at low environmental doses or at biomonitored levels from low environmental exposures are unknown. It is also not known if the measured amount of BP-3 in urine reflects exposure levels that can cause adverse health effects.

BP-3 is a suspected endocrine disruptor. This aspect introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. The suspected endocrine disruptive effects of BP-3 are currently being investigated during substance evaluation under REACH (in 2014). This investigation may either lead to a request for more data to clarify the concern, to a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH (article 57(f) or to a conclusion that the available data are adequate to conclude that the substance is not of concern. This issue is expected to be resolved in 2015.

6.2.2 Octocrylene (OC) (CAS No. 6197-30-4)

Basis for MOS calculation
The hazard assessment summary (section 5.3.2) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis the information is not

considered as being sufficient for the safety assessment of octocrylene as a UV filter in cosmetic products.

According to the REACH registration dossier (ECHA, 2014A), octocrylene is absorbed through the gastrointestinal tract. In *in vitro* and *in vivo* dermal absorption studies with human skin, the recovery in the stratum corneum after 30 minutes (as percentage of applied dose) was 2.8±1.6 and 4.8±1.4, respectively. The authors of this report cannot make a conclusion regarding dermal absorption based on the available data, but consider 10 % as a worst case dermal absorption, the percentage used for the preliminary MOS calculation for use of octocrylene in sunscreens and other cosmetic formulations.

Based on a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 175 mg/kg bw/day was determined (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 175 mg/kg bw/day is therefore used for the preliminary MOS calculation.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

MOS calculation for application of sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), octocrylene is allowed as a UV filter in cosmetic products with a maximum concentration of 10% (as acid) in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	180mg/day
Systemic exposure dose (SED)	1800/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	175 mg/kg bw/day
MOS	NOAEL/SED	=	58 (< 100)

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 29 (< 100).

MOS calculation for application in other cosmetic products
In the shop survey, OC was found in 76 out of 291 products. Of these, 54 products were sunscreen products and 12 products were face creams. Other products included foundation, handcream, lip balm, makeup and nail polish remover. The preliminary MOS calculations for use of octocrylene in these cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg

Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	174 mg/day
Systemic exposure dose (SED)	1740/60	=	2.9 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	175 mg/kg bw/day
MOS	NOAEL/SED	=	60 (< 100)

Use in other products
OC has not been identified in other product types as part of the market survey.

OC is registered under REACH in the tonnage band 1,000 – 10,000 tonnes per year with uses including cosmetic and personal care products, perfume and fragrances, coatings and paints, thinners, paint removers, fillers, putties, plasters, modelling clay, polymer preparations and compounds, photochemicals and pharmaceuticals. The substance is registered in the Danish Product Register, but no information on uses is available in the SPIN database.

Total exposure
Use in cosmetics is expected to contribute significantly to the total exposure to octocrylene.

Other direct exposure may be possible from mixtures such as coatings, paints and varnishes, sealants, etc. as well as exposure from migration from modelling clay and polymeric materials in different articles. However, no information regarding these uses was received as part of the market survey.

Typical concentrations of UV filters and absorbers in paint type products are reported to be around 0.1%, or one hundredth of the maximum allowed concentration of OC as a UV filter in cosmetics. Even assuming as a worst case scenario that other product types containing OC are used on a daily basis, the actual amount of product in contact with the body is expected to be significantly lower that the estimated amounts of cosmetic products.

OC has been found in drinking water (from surface water) in different European countries, but it is not known if this is also the case in Denmark.

OC has furthermore been measured in the environment as well, as it has been identified in biomonitoring studies in Switzerland. No information from Danish studies has been identified. OC was among the targets for developing new human biomonitoring methods by the The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety in Germany in 2014 (BUND, 2014).

Conclusion
Based on a preliminary safety assessment on data solely available in the REACH registration dossier (ECHA, 2014A), the use of octocrylene as a UV filter at the maximum amount of 10% (acids) in sunscreens and other cosmetic products can pose a risk for the consumer (MOS <100). However, it should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of octocrylene as a UV filter in cosmetic products.

Furthermore, based on information from market stakeholders, the actual amount of OC used in sunscreen and in cosmetic products is likely lower than the maximum allowed concentration of 10%.

OC is registered at a high tonnage level with potentially widespread uses. The market survey has, however, only identified the substance in cosmetic products.

OC has been identified in biomonitoring studies and it has been measured in drinking water (surface water) and in the environment, indicating relatively high consumer exposure from cosmetics and possibly other sources. The substance is used in many different cosmetic products for all-year use and it is not possible to conclude whether human load and the release to the environment occurs from cosmetic products only or from other product types as well.

The substance is a suspected endocrine disruptor. This possibility introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. Further testing of octocrylene has been requested after substance evaluation under REACH, in order to resolve a concern regarding endocrine disruptive effects. The deadline for the registrants to submit information on the new studies to ECHA is September 2016.

6.2.3 Benzophenone-1 (BP-1) (CAS No. 131-56-6)

Basis for MOS calculation

The hazard assessment summary (section 5.3.3) is based on data available in the REACH registration dossier (ECHA, 2014) as well as information from two scientific studies (Jeon et al., 2008; Liebert et al., 1983). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

No data on absorption of BP-1 is available from either the registration dossier (ECHA, 2014) or the scientific literature. In accordance with the SCCS's Notes of Guidance (SCCS, 2012), a dermal absorption of 100% should be used for calculation of MOS, when the log Kow of the substance <4 and the MW < 500, which is the case for BP-1 (log Kow = 2.96 and MW = 214.1).

Available toxicity studies indicate a very low acute toxicity of BP-1 (LD50, rat, oral: 8600 mg/kg bw), and low subchronic toxicity (NOAEL, rat, oral: 236 mg/kg bw/day). Like other benzophenones, BP-1 is not mutagenic. The lowest effect levels were determined for reproductive toxicity with lowest observable adverse effect levels (LOAELs) of 100-625 mg/kg bw/day and NOAELs of 100-250 mg/kg bw/day. The authors of this report cannot make a conclusion on a NOAEL based on the available data. A NOAEL of 236 mg/kg bw/day for repeated dose toxicity (oral) is suggested by the REACH registrant and will be used for the preliminary MOS calculation.

A minority of CLP notifiers have suggested a classification as skin sensitizing. This classification is, however, not supported by the identified studies included in the hazard assessment and may need further clarification.

MOS calculation for application of sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), BP-1 is not allowed as a UV filter in cosmetic products; MOS calculations for the application in sunscreen are therefore not carried out.

MOS calculation for application in other cosmetic products

Benzophenone-1 has been identified in five nail polish products only. BP-1 has not been identified in other product types as part of the market survey, and the preliminary MOS calculation is therefore based on the use of BP-1 in nail polish, using default exposure values from the Nordic Council of Ministers (2012). It is assumed that the total area of a fingernail is 1.5 cm^2, giving a total area of all fingernails of 15 cm^2. The area of exposed skin surrounding the nails is assumed to be 4

cm^2, giving a total area of 19 cm^2 to be covered with nail polish. The amount of product used is assumed to be 0.25 g. However, as no absorption from the nails is expected, only exposure to the surrounding skin is included. Thus, the amount of nail polish to reach the skin is calculated to be 0.25 x 4/19 = 0.05 g. The frequency of application is 0.43 times/day (i.e. 2-3 times per week, or 156 times per year). The total amount of nail polish applied daily is therefore 0.05 g x 0.43 times/day = 0.0215 g/day.

The preliminary MOS calculations for use of BP-1 in these cosmetics are performed with a concentration of 1%. This concentration is based on data from the market survey suggesting that the concentration of BP-1 as a UV absorber is expected to be between 0-1% in mixtures, and 1% thus represents a worst case value.

Amount of cosmetic product applied daily	A	=	21.5 mg/day
Concentration of ingredient in finished product (C)		=	1%
Total amount of active ingredient applied	(Q_i) = Q x C	=	0.215 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	100%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	0.215 mg/day
Systemic exposure dose	0.215/60	=	0.00358 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	236 mg/kg bw/day
MOS	NOAEL/SED	=	66,000

Use in other products

In the literature, BP-1 is reported to be used in textiles (e.g. automotive textiles), paints, varnishes, adhesives and sealants and food packaging. Market players furthermore confirm the use of BP-1 in articles made from plastics and polymers. The substance has been measured in food. The concentration of BP-1 as a UV absorber in other product types in the form of mixtures is expected to be between 0 and 1%, and in textiles and polymeric materials in articles from which the substance can migrate, between 0 and 3%. BP-1 may also be used as an absorber in cosmetic products other than nail polish, although this was not confirmed by the market survey.

BP-1 is registered under REACH for use in cosmetic and personal care products, and in polymer preparations and compounds. The volume registered under REACH is low (0-10 tonnes per year) and does not indicate widespread use of the substance. The substance is registered in the Danish Product Register, but no information on uses is available in the SPIN database.

Total exposure

The results of the survey indicate that use in cosmetic products is not the major source of the expected exposure to BP-1. As a worst case assumption, UV-treated textiles may be used daily, but most likely not directly in contact with the skin, except in summertime when UV-treated bathing suits and sports clothes may be used. Measurements of the migration of UV-absorbers from articles in contact with skin have not been identified, but are expected to be low as the substances are designed to remain in the materials in order to maintain the quality of the products. Furniture, surfaces and articles coated with e.g. paints and varnishes may release small amounts of the substances to the indoor environment, e.g. dust, which can be inhaled and ingested.

Direct exposure may be possible from paints, varnishes, adhesives and sealants and from migration to food. However, no information regarding these uses was received as part of the market survey. Typical concentrations of UV filters and absorbers in paint type products are reported to be in the range of 0.1%. UV filters and absorbers in textiles are typically reported to be in the range of 1-3%.

Exposure from migration of the substances from articles including textiles and polymeric material is considered possible. However, no information regarding migration has been identified.

Conclusion
Based on a preliminary assessment and the assumptions made, the use of BP-1 as a UV absorber in nail polish at concentrations up to 1% is not expected to pose a risk to consumers (MOS >> 100), even using a conservative worst case scenario of 100% absorption and a concentration of 1% in the nail polish. It should, however, be noted that BP-1 may be used as a UV absorber in other cosmetic products leading to consumer exposure, even though this use was not identified in the market survey.

It should also be noted that only limited information is available from the publicly available summaries of the substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of BP-1 as a UV absorber in cosmetic products.

No specific uses involving high exposures of BP-1 have been identified as part of the market survey. Widespread use is not expected based on REACH registration volumes. No information on uses or volumes is available in the SPIN database. No human biomonitoring studies have been identified involving BP-1 and no identified studies have reported measurements of BP-1 in either drinking water or the environment.

BP-1 is a suspected endocrine disruptor. This issue introduces some uncertainty in the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. The suspected endocrine disruptive effects of BP-1 are currently being considered in the context of a Risk Management Option Analysis (RMOA) under REACH. Whether this analysis will lead to a need for further evaluation of the substance, or a proposal to identify the substance as an endocrine disruptor under REACH, remains to be resolved.

6.2.4 4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9)

Basis for MOS calculation
The hazard assessment summary (section 5.3.4) is based on an SCCP opinion published in 2008 (SCCP, 2008b).

Recent *in vitro* data on pig skin presented in the SCCP publication indicate a dermal uptake of 1.1%, which will be used in the calculation of the MOS (SCCP, 2008b).

Based on a subchronic repeated dose study performed in rats, a NOAEL of 25 mg/kg bw/day may be considered according to the SCCP opinion (SCCP, 2008b) and the authors of this report agree with the evaluation of this opinion.

MOS calculation for application in sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), 4-MBC is allowed as a UV filter in cosmetic products with a maximum concentration of 4% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 4%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	4%
Total amount of active ingredient applied	(Q_i) = Q x C	=	720 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	1.1%

Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	7.92 mg/day
Systemic exposure dose (SED)	7.92/60	=	0.132 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral toxicity study, rats)		=	25 mg/kg bw/day
MOS	NOAEL/SED	=	190

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 95 (< 100).

MOS calculation for application in other cosmetic product

The survey did not find the substance in any cosmetic products, but it has been found in cosmetics by Rastogi (2002) and is also mentioned by Krause et al. (2012) as one of the most frequently used UV filters in cosmetics. Thus, a preliminary MOS is calculated for general use of 4-MBC in cosmetics, using the maximum allowed concentration, i.e. 4%. The amount of cosmetic product applied daily is set at 17.4 g/day for all cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product	(C)	=	4%
Total amount of active ingredient applied	(Q_i) = Q x C	=	696 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	1.1%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	7.66 mg/day
Systemic exposure dose (SED)	7.66/60	=	0.13 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral toxicity study, rats)		=	25 mg/kg bw//day
MOS	NOAEL/SED	=	200

Use in other products

4-MBC has not been identified in other products according to the market survey, and it is not mentioned as being used by Danish industry and other market players.

4-MBC is pre-registered under REACH indicating that there is an intention to register the substance at the next submission deadline for registration of substances manufactured or imported at 1-100 tonnes per year on 31 May 2018. No registration has been identified for the Danish market in the SPIN database.

Total exposure

Cosmetic products are identified as a source of exposure to 4-MBC in the literature in this survey, although the substance is not found in the shop survey of cosmetic products. 4-MBC has been found in drinking water (from surface water) in different European countries, but it is not known if this is also the case for Denmark. 4-MBC has also been measured in the environment and it has been identified in biomonitoring studies from both Switzerland and Denmark and not only during summer.

Conclusion

Based on information from the SCCP report, the use of 4-MBC as a UV filter at the maximum allowed concentration of 4 % in sunscreens leads to a calculated MOS of 95 in the scenario with an application of 36 g/day. However, the SCCS (SCCS, 2008) has accepted using toxicokinetic data from an expert opinion for 4-MBC which allows a MOS of 25 to be used as threshold for the safety

assessment. Using this threshold, the calculated MOS value does not indicate a risk for the consumer.

4-MBC has been identified in biomonitoring studies in the winter months as well, indicating exposure of consumers from sources other than sunscreens. 4-MBC has also been measured in drinking water (from surface water) and in the environment. It is not possible to conclude whether exposure in the winter time occurs from other cosmetic products, drinking water or from other product types.

4-MBC is a suspected endocrine disruptor. This issue introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. The suspected endocrine disruptive effects of 4-MBC are currently being considered in the context of a Risk Management Option Analysis (RMOA) under REACH. Whether this analysis will lead to a need for further evaluation of the substance, or a proposal to identify the substance as an endocrine disruptor under REACH, remains to be seen.

6.2.5 2-Ethylhexyl 4-(dimethylamino)benzoate (OD-PABA) (CAS No. 21245-02-3)

Basis for MOS calculation

The hazard assessment summary (section 5.3.5) is based on two articles published in scientific journals (Kenney et al., 2005; León et al., 2010), as well as an EFSA opinion (EFSA, 2005). The information on OD-PABA is therefore limited.

An *in vitro* dermal absorption study with hairless guinea pig skin showed a substantial absorption of OD-PABA, at levels of 42.5% and 11.6% absorption using ethanol and lotion vehicles, respectively (Kenney et al., 2005). For the calculation of MOS in relation to cosmetics, the lotion vehicle appears more relevant, and a dermal absorption of 11.6% is therefore used for the MOS calculation.

A NOAEL of 100 mg/kg bw/day established by EFSA based on evidence of pigmentation of the spleen in females in a 28-day oral toxicity study is used for the MOS calculation.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), OD-PABA is allowed as a UV filter in cosmetic products with a maximum concentration of 8% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowable concentration of 8%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	8%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1440 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	11.6%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	167 mg/day
Systemic exposure dose (SED)	167/60	=	2.8 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subacute oral toxicity study, rats)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	36 (< 100)

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 18 (<100).

MOS calculation for application in other cosmetic product
OD-PABA was identified in 1 sunscreen product and 1 foundation in the shop survey. The preliminary MOS calculations for use of OD-PABA in these cosmetics are performed with the maximum allowed concentration, i.e. 8%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product	(C)	=	8%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,392 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	11.6%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	161.5 mg/day
Systemic exposure dose (SED)	161.5/60	=	2.7 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subacute oral toxicity study, rats)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	37 (<100)

Use in other products
The substance has been identified in paints, varnishes, adhesives, sealants, inks for food packaging and other uses as part of the market survey.

OD-PABA is pre-registered under REACH indicating that there is an intention to register the substance at the next submission deadline for registration of substances manufactured or imported at 1-100 tonnes per year on 31 May 2018. The substance is registered for the Danish market in the SPIN database, but no information on applications or amounts are available.

Total exposure
Cosmetic products are identified as a source of exposure to OD-PABA in a few cosmetic products in the shop survey (1 foundation and 1 sunscreen).

Direct exposure may also be possible from paints, varnishes, adhesives and sealants and from migration of the substance used in printing inks for food packaging into food.

Exposure from migration of the substances from coatings is also considered possible. However, no information regarding migration has been identified. Furniture, surfaces and articles coated with e.g. paints and varnishes may release small amounts of the substances to the indoor environment, e.g. dust which can be inhaled and ingested.

OD-PABA has furthermore been found in drinking water (from surface water) in different European countries as well as in the aquatic environment, but it is not known if this is also the case in Denmark.

Conclusion
Based on a preliminary assessment of data from EFSA (2005) and two scientific articles (Kenney et al., 2005; León et al., 2010), the use of OD-PABA as a UV filter in sunscreen and cosmetic products can pose a risk for consumers (MOS < 100) both when applied at 18 g per day and at 36 g per day when used at the maximum allowed concentration of 8%. It should however be stressed that the information is considered limited.

OD-PABA has been identified in biomonitoring studies and it has been measured in drinking water and in the environment, indicating relatively high consumer exposure. It is not possible based on

the results of the survey to conclude whether the human load and the release to the environment occur from cosmetic products only or from other product types.

6.2.6 Titanium dioxide (CAS No. 13463-67-7)

The hazard assessment summary (section 5.3.6) is solely based on the SCCNFP (2000) (micro-crystalline) and SCCS (2014) (nano) opinions. The information is considered as being sufficient for the safety assessment of titanium dioxide as a UV filter in cosmetic products.

According to the Cosmetics Regulation (EU Regulation 1223/2009), titanium dioxide is allowed as a UV filter in cosmetic products with a maximum concentration of 25% in ready-for-use preparations.

For micro-crystalline titanium dioxide, the SCCNFP concluded that the toxicological profile does not give rise to concern in human use, since the substance is not absorbed through the skin. In view, also, of the lack of percutaneous absorption, a MOS calculation has not been carried out (SCCNFP, 2000). The authors of this report agree with the evaluation of the SCCNFP and therefore no MOS is calculated.

On the basis of the available evidence, the SCCS concluded that the use of titanium dioxide nanomaterials with the characteristics as indicated in the opinion, at a concentration up to 25% as a UV-filter in sunscreens, can be considered to not pose any risk of adverse effects in humans after application on healthy, intact or sunburnt skin. Given the very low, if any, dermal penetration of nano titanium dioxide when applied on skin, and in consideration of the low toxicity observed, the MOS calculation is not relevant. This, however, does not apply to applications that might lead to inhalation exposure to titanium dioxide nanoparticles (such as powders or sprayable products). In view of the concerns over safety of nano titanium dioxide via the inhalation route, its use in applications that might lead to inhalation exposure (such as powders or sprayable products) is not recommended and a MOS has therefore not been calculated. The assessment applies to the titanium dioxide nanoparticles presented in the submission, but may also be applicable to other titanium dioxide nanomaterials that are similar to the parameters in Tables 1-3 in the opinion (SCCS 2014). The authors of this report agree with the evaluation of the SCCS.

Use in cosmetic and other products

In the shop survey, titanium dioxide (non-nano) was identified in 48 products including 33 sunscreen products and 2 face cream products. In the nano-form the substance was identified in 43 products including 30 sunscreen products and 3 face creams. The substance in both forms was also found in foundation and makeup. In addition, the non-nano-form was found in powder and the nano-form was found in hand cream.

According to the market survey, titanium dioxide in both the non-nano-form and the nano-form has widespread use in textiles, polymeric materials and toys.

Titanium dioxide is registered under REACH at 1,000,000 – 10,000,000 tonnes per year with more than 40 registered uses. In the SPIN database, the substance is registered for uses including paints and varnishes (water based and solvent based), fillers, cement, mortar, colourants and sealants. Titanium dioxide is consequently the most used UV filter and absorber among the 19 selected substances.

Total exposure

Titanium dioxide is the UV filter with the most diverse use profile and the substance is registered in the highest amounts. In addition, the substance has the highest allowed concentration in cosmetics with 25% as a maximum for both the non-nano-form and the nano-form. With regard to titanium dioxide in the nano-form, 5% is allowed in the anatase form.

The use in cosmetics is expected to account for the main exposure by the dermal route.

Conclusion
The use of micro-crystalline titanium dioxide as a UV filter in cosmetic products up to 25% does not pose a risk for the consumer (no percutaneous absorption).

The use of titanium dioxide in its nano form as a UV filter of up to 25% with the characteristics indicated in the SCCS opinion (SCCS 2014) does not pose a risk for the consumer when applied on the skin (very low, if any, percutaneous absorption).

Use in applications that might lead to inhalation exposure (such as powders or sprayable products) is not recommended (concerns over safety of nano titanium dioxide via inhalation route).

6.2.7 Butyl methoxydibenzoylmethane (BMDBM) (CAS No. 70356-09-1)

Basis for MOS calculation
The hazard assessment summary (section 4.3.7) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis the information is not considered as being sufficient for the safety assessment of BMDBM as a UV filter in cosmetic products.

BMDBM shows a very low percutaneous absorption in humans. In an *in vitro* dermal absorption study with human skin (2% BMDBM in water-oil cream) dermal absorption increased with exposure time to about 10% after 18 hours. In an *in vitro* dermal absorption study with pig skin (2 or 7.5% BMDBM in oil-water lotion, oil-water cream or water-oil cream) almost the whole amount (= 95%) remained on the skin surface; skin absorption/penetration was not affected by the different vehicles. The authors of this report cannot conclude about dermal absorption based on the available data. As a worst case, a dermal absorption of 10% is used for the preliminary MOS calculation for use of BMDBM in sunscreens and other cosmetic formulations.

Based on a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 450 mg/kg bw/day was determined (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 450 mg/kg bw/day is used for the preliminary MOS calculation.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

MOS calculation for application in sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), BMDBM is allowed as a UV filter in cosmetic products with a maximum concentration of 5% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 5%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	900 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	90 mg/day
Systemic exposure dose (SED)	90/60	=	15 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	450 mg/kg bw/day

(subchronic oral repeated dose toxicity study, rats)

MOS	NOAEL/SED	=	300

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 150.

MOS calculation for application in other cosmetic products

In the shop survey, BMDBM was found in 119 cosmetic products, including 76 sunscreen products and 6 face creams in the shop survey. Other products included body wash, cream, day cream, eau de toilette, foundation, hand cream, lip balm, makeup, and perfume. The preliminary MOS calculations for use of BMDBM in these cosmetics are performed with the maximum allowed concentration, i.e. 5%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	870 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	87 mg/day
Systemic exposure dose (SED)	870/60	=	1.45 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	450 mg/kg bw/day
(subchronic oral repeated dose toxicity study, rats)			
MOS	NOAEL/SED	=	310

Use in other products

BMDBM was identified as being used in toys in the market survey. No other uses were identified.

BMDBM is registered under REACH at 1,000 – 10,000 tonnes per year. Registered uses are cosmetic and personal care products, perfume and fragrances. The substance is not registered in the SPIN database.

Total exposure

The use in cosmetics is expected to account for the main source of exposure to BMDBM.

BMBDM has been identified in the aquatic environment.

Conclusion

Based on a preliminary safety assessment on data solely available in the REACH registration dossier (ECHA, 2014A), the use of BMDBM as a UV filter at levels of up to 5% in cosmetic products does not pose a risk for the consumer (MOS ≥300).

However, it should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of BMDBM as a UV filter in cosmetic products.

Furthermore, the actual amount of BMDBM used in sunscreen and in cosmetic products is likely to be lower than the maximum allowed concentration of 5% based on information from market stakeholders.

BMDBM is found in the aquatic environment, indicating a certain environmental exposure from cosmetics released to surface water from recreational use of the water or wastewater released to the waters.

6.2.8 Ethylhexyl salicylate (CAS No. 118-60-5)

Basis for MOS calculation

The hazard assessment summary (section 5.3.8) is based on the SCC (Scientific Committee on Cosmetology) (2000) opinion, the CIR (2003) review, and one scientific publication (Lapczynski et al., 2007), as well as data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis the information is considered as being sufficient for the safety assessment of ethylhexyl salicylate as a UV filter in cosmetic products.

In *in vitro* dermal absorption studies with human skin, the dermal absorption was low with absorption of 0.65-1.14% of the applied dose (ECHA, 2014A). The SCC considered an overall percutaneous absorption of 0.5% (SCC, 2000). The authors of this report agree with the evaluation of the SCC; a dermal absorption of 0.5% is used for the MOS calculation for use of ethylhexyl salicylate in sunscreens and other cosmetic formulations.

Based on a subchronic oral repeated dose toxicity study performed in rats, a NOAEL of 250 mg/kg bw/day may be considered (SCC, 2000; ECHA, 2014A). The authors of this report can agree with the evaluation of the SCC; a NOAEL of 250 mg/kg bw/day is used for the MOS calculation.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), ethylhexyl salicylate is allowed as a UV filter in cosmetic products with a maximum concentration of 5% in ready-for-use preparations. For use in sunscreens, the MOS calculation is performed with the maximum allowed concentration of 5%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	900 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.5%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	4.5 mg/day
Systemic exposure dose (SED)	4.5/60	=	0.075 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	250 mg/kg bw/day
MOS	NOAEL/SED	=	3300

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 1700.

MOS calculation for application in other cosmetic product
In the survey, ethylhexyl salicylate has also been found in other cosmetic products such as face cream, body wash, cream, day cream, eau de toilette, foundation, hand cream, lip balm, makeup and perfume. Ethylhexyl salicylate was identified in 84 cosmetic products, including 45 sunscreen products and 16 face creams in the shop survey. The MOS calculations for use of ethylhexyl salicylate in these cosmetics are performed with the maximum allowed concentration, i.e. 5%.

The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product	(C)	=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	870 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.5%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	4.35 mg/day
Systemic exposure dose (SED)	4.35/60	=	0.073 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	250 mg/kg bw/day
MOS	NOAEL/SED	=	3,400

Use in other products
Ethylhexyl salicylate was not identified in other products in the market suvery.

Ethylhexyl salicylate is registered under REACH at 100 – 1000 tonnes per year. The substance is reported for use in cosmetics and personal care, and perfume and fragrances. No registration for the Danish market has been identified in the SPIN database.

Total exposure
The use in cosmetics is expected to account for the main source of exposure to ethylhexyl salicylate.

Conclusion
The use of ethylhexyl salicylate as a UV filter at levels up to 5% in cosmetic products does not pose a risk for the consumer (MOS >3,000).

6.2.9 Ethylhexyl triazone (CAS No. 88122-99-0)

Basis for MOS calculation
The hazard assessment summary (section 5.3.9) is based on data available in the REACH registration dossier (ECHA, 2014A), as well as the study by Monti et al. (2008). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

According to the registration dossier, an *in vitro* test with human epidermis showed absorption of 1.3% at the highest tested dose (ECHA, 2014A). However, the authors of this report cannot conclude on dermal absorption based on the available data. As a worst case, a dermal absorption of 10% is used for the preliminary MOS calculation for use of ethylhexyl triazone in sunscreens and other cosmetic formulations in accordance with the SCCS's Notes of Guidance (SCCS, 2012), as the MW > 500 and log Kow > 4 for ethylhexyl triazone (MW = 822.5 and log Kow > 7).

Based on a subchronic oral repeated dose toxicity study in rats, a NOAEL of 1,000 mg/kg bw/d was determined (ECHA, 2014A). As the authors of this report cannot conclude on the NOAEL based on the available data, the NOAEL of 1000 mg/ kg bw/d is used for calculating a preliminary MOS.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), ethylhexyl triazone is allowed as a UV filter in cosmetic products with a maximum concentration of 5% in ready-for-use preparations. For use in sunscreens the preliminary MOS calculation is performed with the maximum allowed concentration of 5%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	900 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	90 mg/day
Systemic exposure dose (SED)	90/60	=	1.5 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	1,000 mg/kg bw/day
MOS	NOAEL/SED	=	670

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 330.

MOS calculation for application in other cosmetic product

In the shop survey, ethylhexyl triazone was was found in 73 cosmetic products, including 70 sunscreen products and 3 face creams. The preliminary MOS calculations for use of ethylhexyl triazone in cosmetics are performed with the maximum allowed concentration, i.e. 5%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	5%
Total amount of active ingredient applied	(Q_i) = Q x C	=	870 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	87 mg/day
Systemic exposure dose (SED)	87/60	=	1.45 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	1,000 mg/kg bw/day
MOS	NOAEL/SED	=	690

Use in other products

Use of ethylhexyl triazone in other products was not identified as part of the market survey.

Ethylhexyl triazone is registered under REACH at 100 – 1000 tonnes per year. The substance is reported for use in cosmetics and personal care products. The substance is registered in the Danish Product Register but no information is available regarding the uses in the SPIN database.

Total exposure
The use in cosmetics is expected to account for the main source of to exposure to ethylhexyl triazone.

Conclusion
The use of ethylhexyl triazone as a UV filter at levels up to 5% in sunscreen and cosmetic products does not pose a risk for the consumer (MOS >100).

6.2.10 Bis-ethylhexyloxyphenol methoxyphenyl triazine (CAS No. 187393-00-6)

Basis for MOS calculation
The hazard assessment summary (section 5.3.10) is based on data available in the REACH registration dossier (ECHA, 2014A), as well as the study by Durand et al. (2009). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

The NOAEL for acute and repeated dose toxicity following oral or dermal exposure is set at 1,000 mg/kg/day, which was the highest dose tested in the studies. No data on dermal absorption have been identified. With a MW > 500 (MW = 627.8) and log Kow > 5.7 the absorption is set at 10%.

MOS calculation for application in sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), bis-ethylhexyloxyphenol methoxyphenyl triazine is allowed as a UV filter in cosmetic products with a maximum concentration of 5% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	180 mg/day
Systemic exposure dose (SED)	180/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	1,000 mg/kg bw/day
MOS	NOAEL/SED	=	330

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 170.

MOS calculation for application in other cosmetic products
In the shop survey, bis-ethylhexyloxyphenol methoxyphenyl triazine was identified in 55 cosmetic products, including 45 sunscreen products and 7 face/day creams. In addition, 3 foundations were identified. The preliminary MOS calculations for use of bis-ethylhexyloxyphenol methoxyphenyl triazine in cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day

Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	174 mg/day
Systemic exposure dose (SED)	174/60	=	2.9 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	1,000 mg/kg bw/day
MOS	NOAEL/SED	=	340

Use in other products
No other uses of bis-ethylhexyloxyphenol methoxyphenyl triazine were identified as part of the market survey.

Bis-ethylhexyloxyphenol methoxyphenyl triazine is registered under REACH at 10 – 100 tonnes per year. The substance is reported for use in cosmetics and personal care products and as laboratory chemical. No information was available in the SPIN database.

Total exposure
The use in cosmetics is expected to account for the main source of to exposure to bis-ethylhexyloxyphenol methoxyphenyl triazine.

Conclusion
The use of bis-ethylhexyloxyphenol methoxyphenyl triazine as a UV filter of up to 10% in sunscreen and cosmetic products does not pose a risk for the consumer (MOS >100).

6.2.11 Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7)

Basis for MOS calculation
The hazard assessment summary (section 5.3.11) is based on data from an SCCP opinion (SCCP, 2008c) and data available in the REACH registration dossier (ECHA, 2014A), as well as the study by Durand et al. (2009).

Several *in vitro* studies on the absorption of diethylamino hydroxybenzoyl hexyl benzoate are available, showing a low dermal absorption in general. An *in vitro* study using rat skin identifies an absorption rate of 10.3% and an *in vivo* rat study identified an absorption rate of 2.3 – 3.2%. Another study with human skin shows an absorption of 0.5%, which, based on species and validity/reliability considerations (as specified by SCCP and on ECHAs homepage) is considered as appropriate for use in the MOS calculations.

Based on a two-generation study in rats, a NOAEL of 100 mg/kg bw/day for several effects was identified as the most sensitive endpoint in the REACH registration dossier; this value will thus be used in the MOS calculation.

According to the Cosmetics Regulation (EU Regulation 1223/2009), diethylamino hydroxybenzoyl hexyl benzoate is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations.

MOS calculation for application in sunscreens
For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day

Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.5%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	9 mg/day
Systemic exposure dose (SED)	9/60	=	0.15 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (Two-generation study, rats)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	670

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 330.

MOS calculation for application in other cosmetic products

In the shop survey, diethylamino hydroxybenzoyl hexyl benzoate was identified in 53 cosmetic products, including 46 sunscreen products and 3 face creams in the shop survey. The preliminary MOS calculations for use of diethylamino hydroxybenzoyl hexyl benzoate in cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product	(C)	=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.5%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	8.7 mg/day
Systemic exposure dose (SED)	8.7/60	=	0.145 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	690

Use in other products

Use of diethylamino hydroxybenzoyl hexyl benzoate in other products was not identified as part of the market survey.

Diethylamino hydroxybenzoyl hexyl benzoate is registered under REACH at 100 – 1,000 tonnes per year. The substance is reported for use in cosmetics and personal care products. The substance is registered in the Danish Product Register but no information is available regarding the uses in the SPIN database.

Total exposure

The use in cosmetics is expected to account for the main source of to exposure to bis- diethylamino hydroxybenzoyl hexyl benzoate.

Conclusion

The use of diethylamino hydroxybenzoyl hexyl benzoate as a UV filter up to 10% in cosmetic products does not pose a risk for the consumer (MOS >100).

6.2.12 Diethylhexyl butamido triazone (CAS No. 154702-15-5)

Basis for MOS calculation

The hazard assessment summary (section 5.3.12) is solely based on data from the REACH registration dossier (ECHA, 2012A). It should be noted that only limited information is available

from the publicly available summaries of the confidential substance registration reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

An *in vitro* study on percutaneous absorption showed absorption between 0.26 and 1.54%. However, the authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% will be used for the preliminary MOS calculation for the use of diethylhexyl butamido triazone in sunscreens and other cosmetic formulations in accordance with the SCCS's Notes of Guidance (SCCS, 2012), as the MW > 500 (765.5) and the log Kow > 4 for diethylhexyl butamido triazone (log Kow = 4.12).

A subchronic oral repeated dose study in rats resulted in a NOAEL of 831 mg/kg bw/day for males and 963 mg/kg bw/day for females (highest dose level). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 831 mg/kg bw/day as suggested by the registrant based on an oral repeated dose toxicity study is used for the preliminary MOS calculation.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), diethylhexyl butamido triazone is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DAp)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	180 mg/day
Systemic exposure dose (SED)	180/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	831 mg/kg bw/day
MOS	NOAEL/SED	=	280

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 140.

MOS calculation for application in other cosmetic products

In the shop survey, diethylhexyl butamido triazone was found in 48 cosmetic products, including 45 sunscreen products and 3 face creams. The preliminary MOS calculations for use of diethylhexyl butamido triazone in cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of sunscreen applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	174 mg/day
Systemic exposure dose (SED)	174/60	=	2.9 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	831 mg/kg bw/day

(subchronic oral repeated dose toxicity study, rats)

MOS	NOAEL/SED	=	290

Use in other products
Use of diethylhexyl butamido triazone in other products was not identified as part of the market survey.

Diethylhexyl butamido triazone is registered under REACH at 100 – 1000 tonnes per year. The substance is reported for use in cosmetics and personal care products. No information was available in the SPIN database.

Total exposure
The use in cosmetics is expected to account for the main exposure to diethylhexyl butamido triazone.

Conclusion
The use of diethylhexyl butamido triazone as a UV filter at levels up to 10% in sunscreen and cosmetic products does not pose a risk for the consumer (MOS >100).

6.2.13 Ethylhexyl methoxycinnamate (OMC) (CAS No. 5466-77-3)

Basis for MOS calculation
The hazard assessment summary (section 5.3.13) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis the information is not considered as being sufficient for the safety assessment of OMC as a UV filter in cosmetic products.

According to the registration dossier (ECHA, 2014A), OMC shows a very low percutaneous absorption in humans. In an *in vitro* dermal absorption study with pig skin (2 or 7.5% OMC in oil-water lotion, oil-water cream or water-oil cream), no more than 4% of OMC was found to be absorbed (ECHA, 2014A). The authors of this report cannot conclude on a dermal absorption based on the available data. As a worst case, a dermal absorption of 10% is used for the preliminary MOS calculation for use of OMC in sunscreens and other cosmetic formulations.

Based on a subchronic oral repeated dose toxicity study and a two-generation toxicity study, both performed in rats, a NOAEL of 450 mg/kg bw/day was determined (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 450 mg/kg bw/day is used for the preliminary MOS calculation.

No data on phototoxicity are included in the Registration dossier (ECHA, 2014A).

MOS calculation for application in sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), OMC is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg

Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	180 mg/day
Systemic exposure dose (SED)	1800/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	450 mg/kg bw/day
(subchronic oral repeated dose toxicity study / two-generation toxicity study, rats)			
MOS	NOAEL/SED	=	150

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 75 (<100).

MOS calculation for application in other cosmetic products

In the shop survey, OMC was found in 59 out of 291 products. Of these, 14 products were sunscreen products and 10 products were face creams. Other products included eau de toilette, foundation, handcream, lip balm, eye cream, shampoo and conditioner, hair treatment, hair oil and body wash. The preliminary MOS calculations for use of OMC in these cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	A	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	174 mg/day
Systemic exposure dose (SED)	174/60	=	2.9 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	450 mg/kg bw/day
(subchronic oral repeated dose toxicity study / two-generation toxicity study, rats)			
MOS	NOAEL/SED	=	160

Use in other products

Use of OMC in other products was not identified as part of the market survey.

Ethylhexyl methoxycinnamate is registered under REACH for use in cosmetic and personal care products, perfume and fragrance, pharmaceuticals and photochemicals, and laboratory chemicals. The volume registered under REACH is in the tonnage band 1,000-10,000 tonnes). The substance is registered in the Danish Product Register, but no information is available regarding the uses in the SPIN database.

Total exposure

The use in cosmetics is expected to account for the majority of exposure to OMC. OMC has furthermore been found in drinking water (from surface water) in different European countries but it is not known if this is also the case in Denmark.

OMC has also been measured in the environment and in biomonitoring studies from Denmark and not only during the summer.

Conclusion

Based on a preliminary safety assessment on data solely available in the REACH registration dossier (ECHA, 2014A), the use of OMC as a UV filter of up to 10% in sunscreen and cosmetic products

does not pose a risk for the consumer (MOS > 100). Based on the assumption that OMC is used at the maximum allowed concentration of 10% and a person applies an amount of 36 g/day, OMC can pose a risk for the consumer, depending on the absorption of the substance.

However, it should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of OMC as a UV filter in cosmetic products.

Furthermore, the actual amount of OMC used in sunscreen and in cosmetic products is likely to be lower than the maximum allowed concentration of 10% based on information from market stakeholders.

OMC has been identified in biomonitoring studies and it has been measured in drinking water and in the environment, indicating a relatively high consumer exposure not only to sunscreen products, but also to the many other cosmetic products which are used all year round.

OMC is a suspected endocrine disruptor. This issue introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. The suspected endocrine disruptive effects of OMC will be investigated during substance evaluation under REACH (in 2015). This investigation will either lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH (article 57(f), or a conclusion that the available data are adequate to conclude that the substance is not of concern. This issue is expected to be resolved in 2016.

6.2.14 Homosalate (CAS No. 118-56-9)

Basis for MOS calculation

The hazard assessment summary (section 5.3.14) is solely based on the SCCP (2007) opinion. The information is considered as being sufficient for the safety assessment of homosalate as a UV filter in cosmetic products.

An *in vitro* dermal absorption study showed that application of a 10% homosalate-containing sunscreen led to a mean dermal absorption of 8.7% in rats and 1.1% in human. The highest absorption found with human skin was 2.0% (SCCP 2007). The SCCP used the highest absorption of 2.0% (for human skin) for the MOS calculation (SCCP 2007). The authors of this report agree with the evaluation of the SCCP; a dermal absorption of 2% is used for the MOS calculation for use of homosalate in sunscreens and other cosmetic formulations.

Based on a 14-day oral repeated dose toxicity study performed in rats, a NOAEL of 100 mg/kg bw/day was derived. The SCCP used this NOAEL for the MOS calculation (SCCP 2007). Based on the assumed metabolism of homosalate and the comprehensive database of the metabolites and with respect to structure relationship evaluations, SCCP (SCCP 2007) considered that there is currently no need for further testing with respect to repeated dose toxicity or to reproductive performance and developmental toxicity. The authors of this report can agree with the evaluation of the SCCP; a NOAEL of 100 mg/kg bw/day is used for the MOS calculation.

MOS calculation for application in sunscreens

According to the Cosmetics Regulation (EU Regulation 1223/2009), homosalate is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations. For use in sunscreens, the MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	2%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	36 mg/day
Systemic exposure dose (SED)	36/60	=	0.60 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (14-day oral repeated dose toxicity study, rats)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	170

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 83 (<100).

MOS calculation for application in other cosmetic products

In the shop survey, homosalate was found in 27 out of 291 products. Of these, 18 products were sunscreen products and 4 products were face creams. Other products included body cream, lip balm, foundation and makeup. According to the SCCP opinion (SCCP 2007), homosalate can also be used as a UV filter at levels of up to 10% in other products than sunscreens. The MOS calculations for use of homosalate in these cosmetics are performed with this concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	2%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	34.8 mg/day
Systemic exposure dose (SED)	34.8/60	=	0.58 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (14-day oral repeated dose toxicity study, rats)		=	100 mg/kg bw/day
MOS	NOAEL/SED	=	170

Use in other products

Use of homosalate in other products was not identified as part of the market survey.

Homosalate is registered under REACH for use in cosmetic and personal care products. The volume registered under REACH is within the tonnage band 100-1000 tonnes per year. No registration has been identified for the Danish market in the SPIN database.

Total exposure

The use in cosmetics is expected to account for the main source of exposure to homosalate. Homosalate has furthermore been measured in the aquatic environment and in biomonitoring studies from Switzerland. It is not known whether these results also are representative for the situation in Denmark.

Conclusion
The use of homosalate as a UV filter at levels of up to 10% in sunscreens, as well as up to 10% in other types of cosmetic products, does not pose a risk for the consumer (MOS >100) when applied in amounts of 18 g/day and below. Based on the assumption that homosalate is used at the maximum allowed concentration of 10% and a person applies an amount of 36 g/day, homosalate may pose a risk to the consumer, depending on the absorption of the substance.

In the discussion section of the SCCP opinion, it is mentioned that an opinion by Roberts (2005, unpublished data from Australia cited in the SCCP opinion (2007)) also reviewed toxicity data on homosalate metabolites which can be formed in the skin, namely salicylic acid and trimethylcyclohexanol. When homosalate after topical application (based on 2% absorption) is assumed to have undergone 100% metabolism to salicylic acid and trimethylcyclohexanol, the estimated SED for salicylic acid is 0.3 mg/kg/day. The SCCNFP 2002 opinion on salicylic acid used a NOAEL of 75 mg/kg for the risk assessment, based on rat oral teratogenicity data. An MOS of 250 can be calculated for salicylate formed as homosalate metabolite. Accordingly, the estimated SED for trimethylcyclohexanol is about 0.31 mg/kg/day. Trimethylcyclohexanol does inhibit HMG CoA reductase. Based on a NOAEL of 43 mg/kg/day (estimated from a LOAEL of 426 mg/kg and an uncertainty factor of 10), a MOS of 143 is calculated for trimethylcyclohexanol. In conclusion, both metabolites of homosalate when formed in skin do not alter SCCP's conclusions on the systemic toxicity of the compound, since MOS for salicylic acid and trimethylcylohexanol are similar to the MOS calculated for homosalate itself.

Homosalate has been identified in biomonitoring studies and in the environment indicating a relatively high consumer exposure to sunscreen products.

6.2.15 Drometrizol trisiloxane (CAS No. 155633-54-8)

Basis for MOS calculation
No data on absorption or NOAEL values have been identified for this substance. No MOS can therefore be calculated.

It should, however, be noted that drometrizol trisiloxane is among the UVA filters which are regularly responsible for cases of photoallergy (Johansen et al. (ed.), 2011). This information is often published with reference to the trade name Mexoryl XL only.

Use in products
In the shop survey, the substance was found in 27 out of 291 products. Of these, 26 products were sunscreen products and 1 product was makeup. No use of drometrizol trisiloxane in other products was identified as part of the market survey.

Drometrizol trisiloxane is pre-registered under REACH, indicating that there is an intention to register the substance at the next submission deadline for registration of substances manufactured or imported at 1-100 tonnes per year on 31 May 2018. No registration has been identified for the Danish market in the SPIN database.

Total exposure
The use in cosmetics is expected to account for the main exposure to drometrizole trisiloxane.

Conclusion
The publicly available toxicity data are insufficient for safety evaluation.

The critical effect identified for drometrizol trisiloxane is photo contact dermatitis. Concerns raised by the FDA (FDA, 2014) requiring additional testing include skin irritation (human) at concentration levels of up to 15%, sensitization and photosafety studies.

6.2.16 Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7)

Basis for MOS calculation

The hazard assessment summary (section 5.3.16) is primarily based on data published under the National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 1996) supplemented by a few articles published in the scientific literature (Benech-Kieffer et al., 2003; Dean et al., 1992, and Foutainer et al., 1992).

A dermal absorption of 0.16% of the applied dose identified in an *in vivo* study in humans is used for the MOS calculation.

A NOAEL of 300 mg/kg bw/day is used for the MOS calculation.

According to the Cosmetics Regulation (EU Regulation 1223/2009), terephthalylidene dicamphor sulfonic acid is allowed as a UV filter in cosmetic products with a maximum concentration of 10% (acid) in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

MOS calculation for application in sunscreens

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.16%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	2.88 mg/day
Systemic exposure dose (SED)	2.88/60	=	0.048 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	300 mg/kg bw/day
MOS	NOAEL/SED	=	6,200

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 3100.

MOS calculation for application in other cosmetic products

In the shop survey, terephthalylidene dicamphor sulfonic acid was found in 21 out of 291 products. Of these, 20 products were sunscreen products and 1 product was makeup. The preliminary MOS calculations for use of terephthalylidene dicamphor sulfonic acid in other cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of sunscreen applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product (C)		=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	0.16 %
Total amount absorbed	A_{abs}= Q_i x DA_p	=	2.78 mg/day
Systemic exposure dose (SED)	2.78/60	=	0.046 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	300 mg/kg bw/day
MOS	NOAEL/SED	=	6,500

Use in other products
Terephthalylidene dicamphor sulfonic acid is pre-registered under REACH indicating that there is an intention to register the substance at the next submission deadline for registration of substances manufactured or imported at 1-100 tonnes per year on 31 May 2018. No registration has been identified for the Danish market in the SPIN database.

Other uses were not identified as part of the market survey.

Total exposure
The use in cosmetics is expected to be the main source of exposure to terephthalylidene dicamphor sulfonic acid.

Conclusion
The use of terephthalylidene dicamphor sulfonic acid as a UV filter of up to 10% in sunscreens, as well as up to 10% in other types of cosmetic products, does not pose a risk for the consumer (MOS >100).

6.2.17 Isoamyl p-methoxycinnamate (CAS No. 71617-10-2)

Basis for MOS calculation
The hazard assessment summary (section 5.3.17) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis the information is not considered as being sufficient for the safety assessment of isoamyl p-methoxycinnamate as a UV filter in cosmetic products.

According to the REACH registration dossier (ECHA, 2014A), isoamyl p-methoxycinnamate shows a very low percutaneous absorption in humans. In an *in vivo* cutaneous penetration study in rats, around 11% of isoamyl p-methoxycinnamate in a water-oil emulsion was absorbed following application for 24 hours. In an *in vitro* dermal absorption study with pig skin (methoxycinnamic acid isoamylester in an oil-water lotion and in a water in oil lotion), the test substance remained predominantly on the skin surface; the absorbed test substance was found predominantly in the horny layer (83-94%). The authors of this report cannot conclude on a dermal absorption based on the available data. A dermal absorption of 10% is used for the preliminary MOS calculation for use of isoamyl p-methoxycinnamate in sunscreens and other cosmetic formulations.

Based on a subchronic oral repeated dose toxicity study and a two-generation toxicity study, both performed in rats, a NOAEL of 200 mg/kg bw/day was determined (ECHA, 2014A). The authors of this report cannot conclude on a NOAEL based on the available data. A NOAEL of 200 mg/kg bw/day is used for the preliminary MOS calculation. No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

MOS calculation for application in sunscreens
According to the Cosmetics Regulation (EU Regulation 1223/2009), isoamyl p-methoxycinnamate is allowed as a UV filter in cosmetic products with a maximum concentration of 10% in ready-for-use preparations. For use in sunscreens, the preliminary MOS calculation is performed with the maximum allowed concentration of 10%:

Amount of sunscreen applied daily	(A)	=	18,000 mg/day
Concentration of ingredient in finished product	(C)	=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,800 mg/day
Typical body weight of human	(bw)	=	60 kg

Absorption of active ingredient	(DA_p)	=	10%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	180 mg/day
Systemic exposure dose (SED)	180/60	=	3 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	200 mg/kg bw/day
MOS	NOAEL/SED	=	67 (<100)

The Danish EPA has also requested performing a MOS calculation for sunscreens with an amount of 36 g applied daily as mentioned in the preamble of the Commission Recommendation. In this case, the calculated MOS is 33 (<100).

MOS calculation for application in other cosmetic products

In the shop survey, isoamyl p-methoxycinnamate was found in 10 out of 291 products. Of these, 9 products were sunscreen products and 1 product a face cream. The preliminary MOS calculations for use of isoamyl p-methoxycinnamate in other cosmetics are performed with the maximum allowed concentration, i.e. 10%. The amount of cosmetic product applied daily is set at 17.4 g/day for cosmetic products (aggregated amounts for cosmetic products), in accordance with the SCCS Notes of Guidance (SCCS, 2012):

Amount of cosmetic product applied daily	(A)	=	17,400 mg/day
Concentration of ingredient in finished product	(C)	=	10%
Total amount of active ingredient applied	(Q_i) = Q x C	=	1,740 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	100%
Total amount absorbed	$A_{abs}= Q_i$ x DA_p	=	174 mg/day
Systemic exposure dose (SED)	1740/60	=	2.9 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL) (subchronic oral repeated dose toxicity study, rats)		=	200 mg/kg bw/day
MOS	NOAEL/SED	=	69 (<100)

Use in other products

The use of isoamyl p-methoxycinnamate in other products was not identified as part of the market survey.

Isoamyl p-methoxycinnamate is registered under REACH for use in cosmetic and personal care products. The volume registered under REACH is within the tonnage band 100-1000 tonnes per year. No registration has been identified for the Danish market in the SPIN database.

Total exposure

The use in cosmetics is expected to account for the main source of exposure to isoamyl p-methoxycinnamate, although isoamyl p-methoxycinnamate was only found in 10 out of 291 products (9 sunscreen products, 1 face cream).

Conclusion

Based on a preliminary safe assessment on data solely available in the REACH registration dossier (ECHA, 2014A), the use of isoamyl p-methoxycinnamate as a UV filter at a concentration of 10% in sunscreens and cosmetic products can pose a risk to the consumer (MOS <100).

However, it should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by

the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of isoamyl p-methoxycinnamate as a UV filter in cosmetic products.

Furthermore, the actual amount of isoamyl p-methoxycinnamate used in sunscreen and in cosmetic products is likely to be lower than the maximum allowed concentration of 10% based on information from market stakeholders.

Isoamyl-p-methoxycinnamate is a suspected endocrine disruptor. This issue introduces some uncertainty in the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. The suspected endocrine disruptive effects of the substance will be investigated during substance evaluation under REACH (in 2016). This investigation may either lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH (article 57(f) or a conclusion that the available data are adequate to conclude that the substance is not of concern. This issue is expected to be resolved in 2017.

6.2.18 Benzophenone (BP) (CAS No. 119-61-9)

Basis for MOS calculation

The hazard assessment summary (section 5.3.18) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

According to the REACH registration dossier (ECHA, 2014A), benzophenone shows a relatively high percutaneous absorption under occlusion of 70% in monkeys. This value will be used for the preliminary MOS calculation although the actual absorption without occlusion is expected to be lower.

Based on a subchronic oral repeated dose toxicity study, a NOAEL of 20 mg/kg bw/day was determined (ECHA, 2014A) and will be used for the preliminary MOS calculation.

According to the Cosmetics Regulation (EU Regulation 1223/2009), benzophenone is not allowed as a UV filter in cosmetic products, and MOS calculations for the application in sunscreen are therefore not carried out.

MOS calculation for application in other cosmetic products

In the shop survey, benzophenone was not found in other cosmetic products. However, since benzophenone is registered under REACH for uses in *inter alia* perfume and fragrances, a preliminary MOS calculation for use of benzophenone in other cosmetics is performed, after all, with a concentration of 1%. The preliminary MOS is calculated based on the use of eau de toilette in accordance with the default values laid out by the Nordic Council of Ministers (2012). The amount upon skin is set at 0.61 g and the frequency of application is set at 3 times/day. Thus the amount of product applied daily is set at 1.83 g/day:

Amount of cosmetic applied daily	(A)	=	1830 mg/day
Concentration of ingredient in finished product	(C)	=	1%
Total amount of active ingredient applied	(Q_i) = Q x C	=	18.3 mg/day
Typical body weight of human	(bw)	=	60 kg
Absorption of active ingredient	(DA_p)	=	70%
Total amount absorbed	A_{abs}= Q_i x DA_p	=	12.81 mg/day
Systemic exposure dose (SED)	12.81/60	=	0.21 mg/kg bw/day
No Observed Adverse Effect Level (NOAEL)		=	20 mg/kg bw/day

(subchronic oral repeated dose toxicity study, rats)

MOS NOAEL/SED = 94 (<100)

Use in other products
According to the market survey, benzophenone is used in toys, paint, varnishes, sealants, fillers, food packaging and printing ink to food packaging and other uses.

Benzophenone is registered under REACH for a number of different uses including perfume and fragrances, coatings, paints, thinners, paint removers, adhesives, sealants, food packaging, inks for food packaging and other uses, cleaning agents, fillers, putties, plasters, modelling clay, finger paints, ink and toners, polymers, and in paper, wood and plastic articles. The volume registered under REACH is within tonnage band 1000-10,000 tonnes per year. The substance is registered in the Danish Product Register with uses including surface treatment, paints, lacquers and varnishes, fillers, cleaning and washing agents.

Total exposure
Exposure to benzophenone is expected from the identified uses in surface coatings, paints, polymers, and toys. Furniture, surfaces and articles coated with e.g. paints and varnishes may release small amounts of the substances to the indoor environment, e.g. dust which can be inhaled and ingested.

Direct exposure may be possible from paints, varnishes, lacquers and fillers, washing agents and from migration to food. Typical concentrations of UV filters and absorbers in paint type products are reported to be in the range of 0.1%.

BP has furthermore been found in drinking water (from surface water); however, this is not considered to contribute to a great extent to the total exposure.

Benzophenone was not identified in any cosmetic products in the market survey. According to the REACH registrations, however, it may be used in perfumes and fragrances, and a MOS has therefore been calculated on the basis of this information. It should, however, be stressed that although BP is registered under REACH for use in these particular products, it does not mean that it actually is used for these products.

Exposure from migration of the substances from articles with polymeric materials is considered possible. However, no information regarding migration has been identified.

Conclusion
Based on a preliminary safety assessment on data solely available in the REACH registration dossier (ECHA, 2014A), the use of benzophenone as a UV absorber at levels of up to 1% in cosmetic products can pose a risk for the consumer (MOS <100).

However, it should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of benzophenone as a UV filter in cosmetic products.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

Benzophenone is a suspected endocrine disruptor. This issue introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine

disruptors can be assessed with reasonable certainty. Under REACH the substance is on the CoRAP list undergoing substance evaluation (initiated in 2013), but not with an initial concern for endocrine disruptive effects. If a concern for endocrine disruption arises during evaluation of the data, it can lead to a request for more data to clarify the concern or a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH. This issue is expected to be resolved in 2015.

6.2.19 Benzophenone-12 (CAS No. 1843-05-6)

Basis for MOS calculation

The hazard assessment summary (section 5.3.19) is solely based on data available in the REACH registration dossier (ECHA, 2014A). It should be noted that only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been subject to scrutiny by ECHA or any EU expert group, or by the authors of this report.

No data on absorption has been identified in the registration dossier. Therefore, a worst case value of 100% will be used for the preliminary MOS calculation in accordance with the SCCS guidance (SCCS, 2012), as the MW > 500 and the log Kow > 7.6 for BP-12 (MW = 326.2; log Kow = 7.6).

Based on a subchronic oral repeated dose toxicity study, a NOAEL of 1,000 mg/kg bw/day was determined based on the highest dose tested (ECHA, 2014A).

According to the Cosmetics Regulation (EU Regulation 1223/2009), benzophenone-12 is not allowed as a UV filter in cosmetic products, and MOS calculations for the application in sunscreen are therefore not carried out.

Use in other products

Other uses identified as part of the market survey included the following product categories: plastic and polymers, toys, paints and varnishes.

Benzophenone-12 is registered under REACH for use in polymer preparations and compounds, adhesives, sealants, coatings and paints, thinners and paint removers, anti-freeze and de-icing products. The volume registered under REACH is within the tonnage band 1,000-10,000 tonnes per year. The substance is registered in the Danish Product Register with information on uses including paints, lacquers and varnishes, additives and lubricants. In the SPIN database, the total amount registered for 2011 is 0.6 tonnes and 0.2 tonnes for paints, lacquers and varnishes.

Total exposure

Exposure to benzophenone-12 is expected from the identified uses in paints, polymers, toys, and surface coatings. Furniture, surfaces and articles coated with e.g. paints and varnishes may release small amounts of the substances to the indoor environment, e.g. dust which can be inhaled and ingested.

Direct exposure may be possible from application of paints, varnishes, lacquers and fillers, and washing agents. Typical concentrations of UV filters and absorbers in paint type products are reported to be in the range of 0.1%.

Exposure from migration of the substances from articles made from polymeric materials is considered possible. However, no information regarding migration has been is identified.

Conclusion

PB-12 is not allowed as a UV filter in cosmetics and no MOS calculations are carried out. Only limited information is available from the publicly available summaries of the confidential substance registrations reports. Furthermore, the information as provided by the registrant has not been

subject to scrutiny by ECHA or any EU expert group, or by the authors of this report. On this basis, the information is not considered as being sufficient for the safety assessment of BP-12.

No data on phototoxicity are included in the registration dossier (ECHA, 2014A).

BP-12 is a suspected endocrine disruptor. This issue introduces some uncertainty into the risk assessment, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty. Under REACH the substance is on the CoRAP list and will undergo substance evaluation (initiated in 2015), with an initial concern for endocrine disruptive effects. This investigation may lead to a request for more data to clarify the concern, a conclusion that the available data are evaluated as adequate to identify the substance as an endocrine disruptor under REACH or a conclusion that the available data are adequate to conclude that the substance is not of concern. This issue is expected to be resolved in 2016.

6.3 Conclusions

The risk assessments of the selected substances have been based on standard scenarios for cosmetic exposure based on available toxicological data and information on dermal absorption rates.

In Table 65, an overview of the calculated margin of safety (MOS) values is presented together with information on the dermal absorption used for the calculation. In addition, the table indicates whether there are other product groups, in addition to cosmetics, likely to result in exposure of the consumer, either by direct contact or by migration from articles. Furthermore, it is indicated whether the health data used for the present evaluation may be considered sufficient for a robust safety evaluation. Where only data from the REACH registration dossier has been used, data are generally considered insufficient as full study reports are not available and proper refinement of the calculation would require more detailed information. In the last column the volumes registered under REACH are presented. Although it is not possible to make direct conclusions regarding the exposure of the consumers from different product types based on the registered volume, it can provide perspective to the assessment of the total potential for consumer exposure – and to the potential for environmental releases and exposure.

As no comprehensive hazard evaluation has been carried out in the present project, more data than those evaluated here may be available for some substances, including in the open literature. It should therefore be emphasized that, irrespective of the calculated results in the present project, the UV filters listed in Annex VI to the Cosmetics Regulation have been evaluated by a scientific committee and found safe for use in cosmetic products up to the maximum allowed concentrations based on the available information at the time of the evaluation. New data may trigger a re-evaluation of the substances and result in revised conclusions.

A resulting MOS < 100 indicates that the combined consumer exposure from cosmetic products and other product categories may add up to pose a risk to the consumer. MOS values < 100 are marked in blue in Table 65.

Finally, identified data gaps specific to the individual substances are mentioned. These data gaps reflect the results of the survey and literature used for the hazard assessment.

TABLE 65
RESULTS OF MOS CALCULATION AND RISK ASSESSMENT

Substance (UV=approved UV filter)	MOS sunscreen 18 g/36 g per day	MOS Aggregate cosmetics excl. sunscreen	DA_p (%)	Non-cosmetic consumer exposure	Health data Availability	Main data gaps based on the reviewed information	Registered amounts under REACH (tonnes)
Benzophenone-3 (BP3) (CAS No. 131-57-7) (UV)	**67 / 33**	1,700	10% 8 %	Yes	Sufficient (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of BP-3 in different products Use/exposure profile Migration data	10-100
Octocrylene (OC) (CAS No. 6197-30-4) (UV)	**58 / 29**	**60**	10 %	Yes	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of OC in different products Dermal absorption Exposure profile Migration data No conclusive NOAEL	1000-10.000
Benzophenone-1 (BP-1) (CAS No. 131-56-6)	-	66.000	100 %	Yes	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of BP-1 in different products Dermal absorption Skin sensitization potential Use/exposure profile Migration data	0-10
4-Methylbenzylidene camphor (4-MBC) (CAS No. 36861-47-9) (UV)	190 / **95** (MOS thres-hold is 25 based on toxicokinetic data)	200	1.1 %	No	Sufficient (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of 4-MBC in different products Link between biomonitoring data, drinking water data, env. data and exposure. Carcinogenicity data	Pre-registeret

Substance (UV=approved UV filter)	MOS sunscreen 18 g/36 g per day	MOS Aggregate cosmetics excl. sunscreen	DA_p (%)	Non-cosmetic consumer exposure	Health data Availability	Main data gaps based on the reviewed information	Registered amounts under REACH (tonnes)
2-Ethylhexyl-4-(dimethylamino)benzoate (OD PABA) (CAS No. 21245-02-3) (UV)	**36 / 18**	**37**	11.6 %	Yes	Not sufficient	Conc. of OD-PABA in different products Use/exposure profile Link between biomonitoring data, drinking water data, env. data and exposure Migration data	Pre-registered
Titanium dioxide (CAS No. 13463-67-7) (UV)	No MOS calculated	No MOS calculated	NA	Yes	Sufficient	No specific data gaps identified	1.000.000-10.000.000
Butyl methoxy-dibenzoylmethane (CAS No. 70356-09-1) (UV)	300 / 150	310	10 %	No	Not sufficient (REACH dossier)	No conclusive NOAEL identified Link between exposure and levels measured in the aquatic environment	1000-10.000
Ethylhexyl salicylate (CAS No. 118-60-5) (UV)	3,300 /1,700	3,400	0.5 %	(No)	Sufficient	No specific data gaps identified	100-1000
Ethylhexyl triazone (CAS No. 88122-99-0) (UV)	670 / 330	690	10 %	No	Not sufficient (REACH dossier)	No specific data gaps identified	100-1000
Bis-ethylhexyloxyphenol methoxyphenyl triazin (CAS No. 187393-00-6) (UV)	330 / 170	340	10 %	No	Not sufficient (REACH dossier)	No specific data gaps identified	10-100
Diethylamino hydroxybenzoyl hexyl benzoate (CAS No. 302776-68-7) (UV)	670 / 330	690	0.5 %	No	Sufficient	No specific data gaps identified	100-1000
Diethylhexyl butamido triazone (CAS No. 154702-15-5) (UV)	280/140	290	1.54 %	No	Not sufficient (REACH dossier)	No specific data gaps identified	100-1000

Substance (UV=approved UV filter)	MOS sunscreen 18 g/36 g per day	MOS Aggregate cosmetics excl. sunscreen	DA_p (%)	Non-cosmetic consumer exposure	Health data Availability	Main data gaps based on the reviewed information	Registered amounts under REACH (tonnes)
Ethylhexyl methoxy-cinnamate (CAS No. 5466-77-3) (UV)	150 / **75**	160	10 %	Yes	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of subst. in different products Phototoxicity data Dermal absorption Use/exposure profile Link between exposure and levels measured in drinking water and the aquatic environment	1000-10.000
Homosalate (HMS) (CAS No. 118-56-9) (UV)	170 / **83**	170	2 %	No	Sufficient	Conc. of subst. in different products Link between exposure and levels measured in drinking water and the aquatic environment	100-1000
Drometrizol trisiloxane (CAS No. 155633-54-8) (UV)	No data	No data	No data	Not known	Not sufficient	Data on toxicity Dermal absorption Use/exposure profile	Pre-registered
Terephthalylidene dicamphor sulfonic acid (CAS No. 92761-26-7) (UV)	6,200 / 3,100	6,500	0.16 %	Not known	Not sufficient (NICNAS dossier)	No specific data gaps identified	Pre-registered
Isoamyl p-methoxy cinnamate (CAS No. 71617-10-2) (UV)	**67 / 33**	**69**	10 %	No	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Conc. of subst. in different products No conclusive NOAEL identified	100-1000
Benzophenone (BP) (CAS No. 119-61-9)	-	**94**	70 %	Yes	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Phototoxicity data Non-occlusive dermal absorption Conc. of subst. in different products Migration data	1000-10.000

Substance (UV=approved UV filter)	MOS sunscreen 18 g/36 g per day	MOS Aggregate cosmetics excl. sunscreen	DA_p (%)	Non-cosmetic consumer exposure	Health data Availability	Main data gaps based on the reviewed information	Registered amounts under REACH (tonnes)
Benzophenone-12 (CAS No. 1843-05-6)	-	-	100 %	Yes	Not sufficient (REACH dossier) (data on potential endocrine disruption not evaluated)	Potential endocrine disruptor Phototoxicity data Use/exposure profile Migration data	

As shown in sections 6.2.1 to 6.2.19 and the summary presented in Table 65, MOS calculations based on the worst case scenarios and data from the reviewed literature indicate that there may be a risk for the consumer in relation to the following substances under the following assumptions:

- Exposure to 18g (36g) sunscreen daily:
  - benzophenone-3 (BP3)
- Exposure to 36 g sunscreen daily:
  - ethylhexyl methoxy-cinnamate (OMC)
  - homosalate (HMS)
- Aggregate exposure and exposure to 18g (36 g) sunscreen daily:
  - octocrylene (OC)
  - 2-ethylhexyl-4-(dimethylamino)benzoate (OD PABA)
  - isoamyl p-methoxy cinnamate
  - benzophenone

Table 65 shows that the UV-filters which are most commonly used on the Danish market based on the shop survey are, in this project, found safe for the consumer in cosmetic products under the given conditions (butyl methoxy-dibenzoylmethan, ethylhexyl salicylate, ethylhexyl triazon, bis-ethylhexyloxyphenol methoxyphenyl triazin and diethylamini hydroxybenzoyl hexyl benzoate). In this project, it has not been possible to perform a risk assessment of titanium dioxide and drometrizol as data were not sufficient. As regards titanium dioxide, the SCCS has recently assessed this UV-filter as safe for consumers under certain conditions. A MOS was not calculated as no percutaneous absorption has been observed.

The risk assessment of BP-3 indicates that the use of BP-3 as a UV filter at the maximum allowed concentration of 10% in sunscreens can pose a risk for the consumer (MOS = 67). However, the results of the survey indicate that BP-3 is not a common UV filter in cosmetics in Denmark. Furthermore, a calculation based on the maximum concentration of 6 % as requested by the applicant (SCCP, 2008a) would result in a MOS >100 (MOS = 112).

When an additional scenario with 36 g sunscreen used daily is assessed (at the request of the Danish EPA and in addition to the conventional method recommended by the SCCS), it indicates a risk for the consumer for 2 UV filters, namely OMC and HMS, although it should be emphasized that a possible risk would depend on the actual dermal absorption from the layer of sunscreen applied.

The risk assessment of the 4 substances, which indicates a risk for the consumers in both sunscreens and in other cosmetic products (worst case scenarios), is based on insufficient data, and

is therefore not adequate, but these UV-filters may warrant further investigation. BP is not allowed as a UV-filter and not found in the shop survey.

Some of the substances in the risk assessment (including some not mentioned above) are suspected to be endocrine disruptors. This issue adds further uncertainty to the risk assessments, since it is still under discussion as to whether thresholds for effects of endocrine disruptors can be assessed with reasonable certainty.

Refinement of the calculation of the systemic exposure dose (SED) would require better knowledge for some of the substances about the following, for example:

- The actual concentration ranges of both UV filters and absorbers in the different product types;
- Systemic toxicity of the substances;
- Dermal absorption studies where these are not available;
- Information about intented uses for pre-registered substances;
- Use and exposure profiles for the different product categories.

Furthermore, in order to evaluate potential exposure from consumer products other than cosmetics, information about migration rates from surfaces and articles from which the substances can migrate are also missing. This missing information involves surface coatings and articles with textile, rubber and plastic materials, and to some extent food contact materials.

Only MOS calculations are made as part of this study as specified in the tender. In order to quantify consumer exposures other than cosmetics, DNEL values should be derived and the risk characterisation ratio should be calculated. However, this kind of research has not been the focus of the present report and data gaps relevant for the present evaluation would also apply to establishment of DNEL values.

7. Main data gaps and uncertainties

The present project has aimed to make an identification and assessment of UV-protective substances based on the same overall approach to all UV substances - and on this basis, to identify areas where knowledge is lacking, as well as to identify substances which, based on this approach, give rise to concern for the health of consumers and/or the environment.

The overall questions to be answered by the project were:

- Which UV filters and UV absorbers are used where?
- What type of UV rays do they protect against?
- What is the exposure of consumers?
- What are the uses of the UV filters and UV absorbers which are found in human biomonitoring studies and in the environment?
- Do the substances have unwanted health effects other than potential endocrine disrupting effects?
- Are the substances problematic in the environment?
- Is there a risk to consumers' health?

When answering these questions, it has also been a goal to identify any missing data that may contribute to qualify the answers. Finally, identifying the UV-protective substances which could be considered sufficiently well-described and safe to use was a goal.

The results of the study of the UV protective substances presented in this report have revealed several data gaps and uncertainties in the assessment of these. The main data gaps and uncertainties in relation to the above-mentioned issues are summarized in the following:

The use of UV filters and UV absorbers in cosmetics:

- The survey shows that UV filters and UV absorbers are used in many types of cosmetics. In some products the substances probably have functions other than UV protection. There is limited information on concentrations and quantities of the substances in the different types of products, which limits an assessment of the extent to which the different product types contribute to the total exposure of the general population and vulnerable groups. Information from manufacturers assessed by SCCS, however, provided evidence in several cases that the concentration of the approved UV filters in sun products may be significantly below the maximum allowed level.
- The shop survey of cosmetics was primarily focused on products which were expected to contain UV filters or UV absorbers. It can, therefore, not be excluded that product types other than those examined could contain UV-protective substances.

The use of UV filters and UV absorbers in other products:

- The survey shows that a large number of UV filters and UV absorbers are used in types of products other than cosmetics, thereby contributing to consumer exposure to the

substances. Some of the substances are identical to those used in cosmetics, while others belong to other substance groups. It is estimated on the basis of the literature survey and contact with market actors that the survey has identified many of the most important substances used. There are, however, a number of uncertainties that influence the assessment of the significance of other products as sources of exposure to humans and the environment. These uncertainties are presented below:

- Information on the total consumption of the individual substances for the various applications is sparse. Registration data can provide some indication of total EU tonnages for the production of mixtures and articles within the EU, but not how much of the registered volume is used as UV filters and UV absorbers in the various types of products.
- For some of the substances there are only indications of their use from the literature, the manufacturers' instructions or the REACH registrations, and thus there is limited knowledge about the extent to which they are actually included in products on the Danish market. The results of the market survey do not rule out the possibility that substances which are not found in survey may be found in products on the Danish market.
- There is limited knowledge about which UV filters and UV absorbers are contained in articles imported from countries outside the EU such as textiles (clothes, automotive textiles, technical textiles, etc.) or articles of plastic, and quantities of the UV filters and UV absorbers imported with these products.

Human biomonitoring of UV filters and UV absorbers:

- There are limited biomonitoring data for UV filters and UV absorbers used exclusively for purposes other than cosmetics. Such data could help to identify how much other uses contribute to the overall exposure. Many of the applications in cosmetics are not seasonal, as the substances often have more than one function. Therefore, lack of seasonal variations in human biomonitoring results cannot alone support the assumption that there are sources of these substances other than cosmetics. It also stressed in connection with levels found in the environment that these may vary significantly as a function of the collection site, the size of the location/system being investigated, the frequency and type of recreational activities, the time of year and the time of the day.

Monitoring of UV filters and UV absorbers in wastewater and in the environment:

- The limited monitoring data for the UV filters and UV absorbers not used in cosmetics demonstrate that other uses may be a source of measured loads on the environment. However, monitoring data is lacking for the majority of UV filters and UV absorbers, which most frequently are used for both cosmetic and other products.
- There is a general lack of quantitative statements linking the use of the substances in various product types to the occurrence of the substances in wastewater and in the environment.
- There is generally limited information on the metabolism of UV filters and UV absorbers found in aquatic organisms and the potential for biomagnification in the food chain.
- No measurements of UV-protective substances in Danish drinking water or the environment have been identified.

PBT and vBvP properties of selected UV filters and UV absorbers:

- For the 19 selected UV filters and UV absorbers included in the assessment, data necessary to evaluate potential PBT/vPvBs properties were missing for about half of the substances.

- For the remaining approximately 70 substances identified in the survey, data are likely to be missing for an even larger proportion, as the selected 19 substances are among the most well described.

Exposure to UV filters and UV absorbers:

- There are very limited data available on the release of UV filters and UV absorbers from products other than cosmetics. Data are available for release from food packaging, but these data cannot be used to determine how much of the content of UV substances in other product types are emitted during the product life cycle.
- There are limited data to determine the extent to which cosmetics other than sunscreens and other sun protection products contribute to the overall exposure.

Health effects of selected UV filters and UV absorbers:

- For many of the substances the amount of data is limited and primarily available from the public part of the REACH registration dossiers. The information herein has not been evaluated by a scientific committee and is not sufficient to make an adequate assessment. The information is therefore taken at face value, including NOAEL values used for the MOS calculation.
- The assessment of 12 of the 19 selected substances is primarily or exclusively based on incomplete data from the industry. Of these, 11 substance evaluations are based on REACH dossiers, and one assessment of data is made from the Australian NICNAS. Two of the 19 substances are currently only pre-registered under REACH and associated data in the open literature are very limited. Five substances have been evaluated by a scientific committee and are considered sufficiently well-desribed.
- For a single substance, drometrizol, which is only pre-registered, only very limited data on toxicity has been identified in the open literature.
- Studies of carcinogenic properties have not been identified for 16 out of 19 substances. Data has only been identified for titanium dioxide, bis-ethylhexyloxophenol methoxyphenyl triazine and benzophenone. Under REACH this type of study is required for registration of substances in tonnage bands of 1000 kg per annum and above.
- Sufficient data on phototoxicity and photoallergy have not been identified for any of the 19 substances.
- There is not sufficient documentation to assess endocrine disrupting properties for any of the 19 substances. Under REACH it is not a requirement for registrants to provide this information, but the Member States may evaluate on a case-by-case basis whether the substances are endocrine disrupters or whether further testing is needed to clarify a concern. Currently, 8 of the 19 substances are under REACH evaluation due to a concern for potential endocrine disrupting effects.
- There is a general lack of information regarding the effect of daily exposure to multiple UV protective substances with potential endocrine disrupting properties.
- The completed MOS calculations include only systemic effects in accordance with the guidelines of the SCCS. Contact allergy and photoallergy are not included and must be assessed separately.

Risk associated with the use of UV filters and UV absorbers in cosmetics, and other types of products:

Missing:

- Information about which UV filters and UV - absorbers are found on the Danish market in the various product types in addition to cosmetics, in order to quantify the total exposure to the substances.
- Information on the concentration levels of the substances used.

- Information on migration of UV filters and UV absorbers from coated surfaces, textiles and articles with plastic and polymer components.
- Knowledge about the importance of the thickness of the applied layer of sunscreen in relation to dermal absorption. This information is relevant for the calculation of MOS values e.g. by application of 1 mg/cm² or 2 mg/cm².

Risk associated with the use of UV filters and UV absorbers which are suspected of being endocrine disruptors:

- When substances suspected of being endocrine disruptors, it involves an uncertainty in the risk assessment, as it is still debatable as to whether threshold values for endocrine disruptive effects can be estimated with reasonable certainty (Hass et al., 2013). There are currently no internationally accepted criteria for the identification of endocrine disrupters, and therefore there is uncertainty as to the potential for endocrine disrupting effects.
- In general, it can be concluded that all UV filters suspected of being endocrine disruptors are under substance evaluation or risk management analysis under REACH where their potential endocrine disrupting properties will be investigated further.

8. List of abbreviations

3-BC	3-Benzylidene camphor
4-MBC	3-(4'-Methylbenzylidene)-dl-camphor
4-MBP	4-Methyl benzophenone
ABS	Acrylonitrile Butadiene Styrene
ABS/SAN	Acrylonitrile Butadiene Styrene/Styrene Acrylonitrile
ACToR	Aggregated Computational Toxicology Resource
ADME	Absorption, Distribution, Metabolism, and Excretion
ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health & Safety)
BCF	Bioconcentration Factor
BEMT	Bis-ethylhexyloxyphenol methoxyphenyl triazine
BMDBM	Butyl methoxydibenzoylmethane
BMF	Biomagnification factor
BP	Benzophenone
BP-1	Benzophenone-1
BP-2	Benzophenone-2
BP-3	Benzophenone-3
BP-4	Benzophenone-4
BP-12	Benzophenone-12
BSAF	Biota-soil accumulation factor
bw	Body weight
CAS	Chemical Abstracts Service
CHO	Chinese Hamster Ovary
Chv	Chronic value
CIR	Cosmetic Ingredient Review
CLP	Classification, Labelling and Packaging
COLIPA	The European Cosmetics Association
CoRAP	Commission Rolling Action Plan
CosIng	Cosmetic Ingredients Database
DEET	N,N-Diethyl-m-toluamide
DHB	2,4-Dihydroxybenzone
DHMB	Dihydroxy-4-methoxybenzone
DHPN	Di-hydroxy-di-n-propylnitrosamine
DMABA	N,N-dimethyl-p-aminobenzoic acid (same as DMP)
DMP	N,N-dimethyl-p-aminobenzoic acid (same as DMABA)
DNA	Deoxyribonucleic acid
DNEL	Derived No Effect Level
DT_{90}	Dissapearence time for first 90% of substance
EC	Effect Concentration
ECHA	European Chemicals Agency
ED	Endocrine Disruptor
EDAB	Ethyl-4-dimethylaminobenzoate
EFSA	European Food Safety Authority
OMC	Ethylhexyl methoxycinnamate

EL50	Loading rate that causes 50% effect
EPA	Environmental Protection Agency
ESIS	The European Service Innovation Scoreboard
EU	European Union
EuPIA	European Printing Ink Association
EVA	Ethylene-vinyl acetate
FHSLA	Florida Health Sciences Library Association
fMNPCE	Frequency of micro nucleated polychromatic erythrocytes
GLP	Good Laboratory Practice
HALS	Hindered Amine Light Stabilizers
Hb	Haemoglobin
HBB	4-hydroxybenzophenone
HDPE	PolyEthylene - High Density
HMS	Homosalate
HPT	Hypothalamic–pituitary–thyroid axis
HPV	High Production Volume
IARC	International Agency for Research on Cancer
IC	Inhibition Concentration
ITX	2-Isopropyl thioxanthone
IUPAC	International Union for Pure and Applied Chemistry
LC	Lethal Effect Concentration
LD	Lethal Effect Dose
LDPE	Polyethylene - Low Density
LL50	Loading rate that causes 50% lethality
LLDPE	Polyethylene - Linear Low Density
LLNA	Local Lymph Node Assay
LOAEL	Lowest Observable Adverse Effect Level
LOD	Limit of Detection
LOEC	Lowest Observable Effect Concentration
Log Kow/Pow	Partition-coefficient (octanol/water)
LOQ	Limit of quantification
LPV	Low Production Volume
MBP	Methylbenzophenone
MET-1	3-(4-carboxybenzylidene)-6-hydroxycamphor
MET-2	3-(4-carboxybenzylidene)-camphor
MITI	Ministry of International Trade and Industry (Japan)
MMP	N-monomethyl-p-aminobenzoic acid
MOA	Mode of Action
MOBB	Methyl-o-benzoylbenzoate
MOS	Margin of safety
MTPO	Modified thermoplastic polyolefins
MW	Molecular Weight
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
nm	Nano meter
NOAEL	No Observed Adverse Effect Level
NO(A)EL	No Observed Adverse Effect Level or No Observable Effect Level
NOEC	No Observed Effect Concentration
NOEL	No Observed Effect Level
NoG	SCCS's Notes of Guidance
NPR	NADPH-cytochrome P450 reductase
OC	Octocrylene
OD PABA	2-Ethylhexyl 4-(dimethylamino)benzoate
OECD	Organisation for Economic Co-operation and Development

PA	Polyamides (nylon)
PABA	P-aminobenzoic acid
PBT	Persistent, Bioaccumulative and Toxic
PBT	Polybutylene terephthalate
PBZ	4-benzoylbiphenyl
PC	Product category
PC	Polycarbonate
PCB	Polychlorinated biphenyl
PCE	Polychromatic erythrocytes
PE	Polyethylene
PET	Polyethylene terephthalate
PMMA	Polymethyl methacrylate
POM	Polyoxymethylene
POP	Persistent Organic Pollutants
PP	Polypropylene
ppm	parts per million
PPO	Polyphenylene oxide
PS	Polystyrene
PS-HI	Polystyrene-High Impact (same as HIPS)
PU	Polyurethane
PVC	Polyvinyl chloride
QSAR	Quantitative Structure and Activity Relationship
RASFF	Rapid Alert System for Food and Feed
RBC	Red Blood Cell
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances (Regulation EC No 1907/2006))
RIPT	Repeat Insult Patch Tests
RIVM	National Institute for Public Health and the Environment (The Netherlands)
ROS	Reactive Oxygen Species
SCC	Scientific Committee on Cosmetology
SCCNFP	Scientific Committee on Cosmetic Products and Non-Food Products intended for consumers
SCCP	Scientific Committee on Consumer Products
SCCS	Scientific Committee on Consumer Safety
SD	Standard Deviation
SD rats	Sprague Dawley rats
SEBS	Styrene Ethylene Butylene Styrene
SED	Systemic Exposure Dosage
SPF	Sun Protection Factor
SPIN	Substances in Products in Nordic Countries (Database of the Nordic Product Registers)
SPT	Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries
T3	Triiodothyronine
T4	Thyroxine
TDI	Tolerable Daily Intake
TG	Test Guideline
THB	2,3,4-trihydroxybenzophenone
TI	Danish Technological Institute
TIETOY	Toy Industries of Europe
TPE	Thermoplastic elastomer
TPU	Thermoplastic polyurethane
TSH	Thyroid stimulating hormone
UPF	Ultraviolet Protection Factor

US EPA	United States Environmental Protection Agency
UV	Ultraviolet (light)
UV-234	2-(2H-benzotriazol-2-yl)-4,6-bis(2-phenyl-2-propanyl)phenol
UV-320	2-Benzotriazol-2-yl-4,6-di-tert-butylphenol
UV-327	2-(5-chloro-2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-propanyl)phenol
UV-328	2-(2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-butanyl)phenol
UV-329	2-(2H-benzotriazol-2-yl)-4-(2,4,4-trimethyl-2-pentanyl)phenol
UVA	Ultraviolet A
UVB	Ultraviolet B
UVC	Ultraviolet C
vPvB	Very persistent and very bioaccumulative
WWTP	Waste water treatment plant

References

Axelstad M., Hass U., Kinnberg K.L., Bjerregaard P. (2013). Assessment of the endocrine disrupting potential of 23 UV-filters, Danish Centre on Endocrine Disrupters, February 2013.

Bachelot M., Li Z., Munaron D., Gall P.L., Casellas C., Fenet H., Gomez E. (2012). Orgnic UV filter in marine mussels from French coastal regions. Science of the Total Environment. 420:273-279.

Balmer ME, Buser HR, Müller MD, Poiger T. (2005). Occurrence of some organic UV filters in wastewater, in surface waters, and in fish from Swiss Lakes. Environ Sci Technol. 15;39(4):953-62.

Benech-Kieffer F, Meuling WJ, Leclerc C, Roza L, Leclaire J, Nohynek G. (2003). Percutaneous absorption of Mexoryl SX in human volunteers: comparison with *in vitro* data. Skin Pharmacol Appl Skin Physiol. 16(6):343-55.

Blüthgen N, Meili N, Chew G, Odermatt A, Fent K. (2014). Accumulation and effects of the UV-filter octocrylene in adult and embryonic zebrafish (*Danio rerio*). Sci. Total Environ. 476-477;207-217.

Brian F, Le Page Y, Piccini B, Cardoso O, Tong S-K, Chung B-C, Kah O. (2012). Screening estrogenic activities of chemicals or mixtures *in vivo* using transgenic (cyp19a1b-GFP) zebrafish embryos. PLosS One, 7, e36069 (as quoted in ECHA, 2014A).

BUND (Federal Mnistry for the Environment, Nature Conservation, Building and Nuclear Safety) (2014). Press release: Federal Environment Ministry and German Chemical Industry Association set new targets for human biomonitoring . 07.07.2014. http://www.bmub.bund.de/en/press/press-releases/detailansicht-en/artikel/bundesumweltministerium-und-chemieverband-setzen-neue-ziele-fuer-human-biomonitoring/

Buser HR, Balmer ME, Schmid P, Kohler M. (2006). Occurrence of UV Filters 4-Methylbenzylidene Camphor and Octocrylene in Fish from Various Swiss Rivers with Inputs from Wastewater Treatment Plants. Environ. Sci. Technol. 40(5):1427–1431.

Canesi L, Lorusso LC, Ciacci C, Betti M, Rocchi M, Pojana G, Marcomini A. (2007). Immunomodulation of Mytilus hemocytes by individual estrogenic chemicals and environmentally relevant mixtures of estrogens: *In vitro* and *in vivo* studies. Aquat. Toxicol. 81: 36-44 (as quoted in ECHA, 2014A).

CDC (2014). Fourth National Report on Human Exposure to Environmental Chemicals. Updated Tables, August, 2014. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention.

Chhabra RS. (2000). NTP technical report on the toxicity studies of benzophenone (CAS No. 119-61-9). Administered in feed to F344/N rats and B6C3F mice. Toxic Rep Ser. (61):1-53, A1-13.

CIR (2003). Safety assessment of Salicylic Acid, Butyloctyl Salicylate, Calcium Salicylate, C12-15 Alkyl Salicylate, Capryloyl Salicylic Acid, Hexyldodecyl Salicylate, Isocetyl Salicylate, Isodecyl Salicylate, Magnesium Salicylate, MEA-Salicylate, Ethylhexyl Salicylate, Potassium Salicylate, Methyl Salicylate, Myristyl Salicylate, Sodium Salicylate, TEA-Salicylate and Tridecyl Salicylate. Reviewed by the Cosmetic Ingredient Review Expert Panel. International Journal of Toxicology, 22

(Suppl. 3): 1-108. Available at: http://online.personalcarecouncil.org/ctfa-static/online/lists/cir-pdfs/pr302.pdf (accessed December 2014).

CIR (2008). Amended final report of the safety assessment of Drometrizole as used in cosmetics. Reviewed by the Cosmetic Ingredient Review Expert Panel. International Journal of Toxicology. 27 (Suppl. 1): 63-75. Available at: http://online.personalcarecouncil.org/ctfa-static/online/lists/cir-pdfs/pr481.pdf (accessed December 2014).

Coronado M, De Haro H, Deng X, Rempel MA, Lavado R, Schlenk D. (2008). Estrogenic activity and reproductive effects of the UV-filter oxybenzone (2-hydroxy-4-methoxyphenyl-methanone) in fish. Aquat Toxicol. 21;90(3):182-7.

CosIng (2014). Søgninger i CosIng (Cosmetic Ingredients Database), Europakommissionens database over indholdsstoffer i kosmetik. http://ec.europa.eu/consumers/cosmetics/cosing/.

DE (2007). Washing and cleaning agents with higly soluble capsules. DE102005038070 A1. Publication date 15 Mar 2007. http://www.google.ee/patents/DE102005038070A1.

Dean SW, Dunmore RH, Ruddock SP, Dean JC, Martin CN, Kirkland DJ. (1992). Development of assays for the detection of photomutagenicity of chemicals during exposure to UV light. II. Results of testing three sunscreen ingredients. Mutagenesis. 7(3):179-82.

Democophes (2013). Human biomonitering på EU-plan. Layman's report. Directorate General for Environment Multilateral and Strategic Affairs LIFE09 ENV/BE/000410. Information available at: http://boernogmiljoe.ku.dk/tilbagemelding (accessed December 2014).

Dewalque, L., Pirard C., Charlier C. (2014). Measurement of Urinary Biomarkers of Parabens, Benzophenone-3, and Phthalates in a Belgian Population. Hindawi Publishing Corporation. BioMed Research International Volume 2014, Article ID 649314, 13 pages.

Díaz-Cruz M.S., Gago-Ferrero P., Llorca M., Barceló D. (2012). Analysis of UV filters in tap water and other clean waters in Spain. Anal Bioanal Chem. 402:2325–2333.

Díaz-Cruz M.S., Llorca M., Barceló D. (2008). Organic UV filters and their photodegradates, metabolites and disinfection by-products in the aquatic environment. Trends in Analytical Chemistry, Vol. 27, No. 10, 2008.

Dubrovski P.D. (Ed.) (2010). Wowen Fabric and Ultraviolet Protection, Woven Fabric Engineering. InTech. Available at: http://www.intechopen.com/books/woven-fabric-engineering/wowen-fabric-and-ultraviolet-protection (accessed January 2015).

Durand L, Habran N, Henschel V, Amighi K. (2009). *In vitro* evaluation of the cutaneous penetration of sprayable sunscreen emulsions with high concentrations of UV filters. International Journal of Cosmetic Science. 31:279–292.ECHA (2014A). Registered Substances. Database on information on registered substances under REACH by search on CAS No. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances (accessed December 2014). European Chemical Agency.
ECHA (2014B). C & L Inventory Database. Information on ECHA's website by search on CAS No. Available at: http://echa.europa.eu/information-on-chemicals/cl-inventory-database/-/cl-inventory/view-notification-summary (accessed December 2014). European Chemical Agency.

ECHA (2014C). Guidance on Information Requirements and Chemical Safety Assessment: Chapter R.11: PBT/vPvB assessment. Version 2.0, November 2014. Available at: http://echa.europa.eu/documents/10162/13632/information_requirements_r11_en.pdf. (accessed December 2014). European Chemicals Agency.

EFSA (2005). Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food on a request from the Commission related to 2-Isopropyl thioxanthone (ITX) and 2-ethylhexyl-4-dimethylaminobenzoate (OD-PABA) in food contact materials. The EFSA journal (2005) 203; 1-15. Available at: http://www.efsa.europa.eu/en/efsajournal/pub/293.htm (accessed December 2014).

EFSA (2012). Scientific Opinion. Guidance on selected default values to be used by the EFSA Scientific Committee, Scientific Panels and Units in the absence of actual measured data. EFSA Journal 2012; 10(3):2579. Available at: http://www.efsa.europa.eu/de/search/doc/2579.pdf

EFSA. (2009). Scientific Opinion. Toxicological evaluation og benzophenone. Scientific Opinion of the Panel on food contact materials, enzymes, flavourings and processing aids (CEF). Adopted on 14 May 2009. Available at: http://www.efsa.europa.eu/de/scdocs/doc/1104.pdf (accessed December 2014).

Environment Agency (2008). UV-filters in cosmetics – prioritisation for environmental assessment, December 2008, Environment Agency of England and Wales. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291007/scho1008bpay-e-e.pdf (accessed December 2014).

EuPIA (2013). EuPIA Suitability List of Photo-initiators for Low Migration UV Printing Inks and Varnishes – February 2013, 2. Corrigendum 2013-05-24. Available at: http://www.eupia.org/uploads/tx_edm/130219_corr2_EuPIA_Suitability_List_of_Photoinitiators_for_Low_migration_UV_Printing_Inks_and_Varnishes.pdf (accessed December 2009).

Europea-Kommissionen (2009). Den Stående Komité for Fødevarekæden og Dyresundhed. Underudvalget for toksikologisk sikkerhed. Konklusioner fra mødet den 6. marts 2009. Tilgængelig online: http://ec.europa.eu/food/food/chemicalsafety/foodcontact/docs/da_20090306statement.pdf.

FDA (Food and Drug Administration) (2014). Re: Docket No. FDA-2003-N-0196 (Legacy Docket No. 2003N-0233). Letter fra FDA, Department of Health and Human Services to L'oreal USA Products Inc., Att. John Thomaszewski, Aug. 29 2014.

Fent K, Zenker, A, Rapp M. (2010). Widespread occurrence of estrogenic UV-filters in aquatic ecosystems in Switzerland. Environ Pollut. 158(5):1817-24.

Fødevarestyrelsen (2010). Afsmitning af 4-methylbenzophenon, benzophenon og andre photoinitiatorer fra fødevarekontaktmaterialer med tryk. Slutrapport. J. nr.: 2010-20-64-00239. Tilgængelig online: http://www.foedevarestyrelsen.dk/SiteCollectionDocuments/25_PDF_word_filer%20til%20download/06kontor/Kontrolresultater/2010/Slutrapport%20trykfarver2.pdf.

FPF (2012). UV filters in paper and board FCMs. Uv filters used in food contact polymer materials which have been measured in food. Food Packaging Forum. October 19, 2012. http://www.foodpackagingforum.org/food-packaging-health/uv-filters-in-paper-and-board-fcms

FPF (2013a). UV filters in polymer FCMs. Uv filters contained in paper and board food packaging materials which have been measured in food. Food Packaging Forum. October 19, 2013. http://www.foodpackagingforum.org/food-packaging-health/uv-filters-in-polymer-fcms

FPF (2013b). Printing ink exposure from FCM significantly underestimated. Food Packaging Forum. October 30, 2013. Available at: http://www.foodpackagingforum.org/research/printing-ink-exposure-from-fcm-significantly-underestimated (accessed January 2015).

Fung W. and Hardcastle M. (2001). Textiles in automotive engineering. The Textile Institute. Woodhead Publishing Limited.

Gago-Ferrero P, Díaz-Cruz MS, Barceló D. (2012). An overview of UV-absorbing compounds (organic UV filters) in aquatic biota. Anal Bioanal Chem. 404(9):2597-610.

Gago-Ferrero P., Alonso M.B.,Bertozzi C.P., Marigo J. Barbosa L., Cremer M., Secchi E.R., Azevedo A., Lailson-Brito Jr. J., Torres J.P.M., Malm O., Eljarrat E., Diaz-Cruz M.S., and Barceló D. (2013). First Determination of UV Filters in Marine Mammals. Octocrylene Levels in Franciscana Dolphins. Environ. Sci. Technol. 47(11):5619–5625.

Grabicova K, Fedorova G, Burkina V, Steinbach C, Schmidt-Posthaus H, Zlabek V, Kocour Kroupova H, Grabic R, Randak T. (2013). Presence of UV filters in surface water and the effects of phenylbenzimidazole sulfonic acid on rainbow trout (Oncorhynchus mykiss) following a chronic toxicity test. Ecotoxicol Environ Saf. 96:41-7.

Hansen, J., Hansen, O.C., Pommer K. (2004). Afgivelse af kemiske stoffer fra telte og tunneler til børn. Kortlægning af kemiske stoffer i forbrugerprodukter, Nr. 46 2004, Miljøstyrelsen.

Hass U, Christiansen S, Axelstad M, Boberg J, Andersson A-M, Skakkebæk NE, Bay K, Holbech H, Kinnberg KL, Bjerregaard P. (2012). Evaluation of 22 SIN List 2.0 substances according to the Danish proposal on criteria for endocrinedisruptors. Danish Centre on Endocrine Disrupters, May 2012

IARC (2010). IARC monographs on the evaluation of carcinogenic risks to humans volume 93: Titanium Dioxide. World Health Organization International Agency for research on cancer. Lyon, France. Available at: http://monographs.iarc.fr/ENG/Monographs/vol93/mono93-7.pdf (accessed December 2014).

Jeon, HK, Sarma, SN, Kim, YJ, Ryu, JC. (2008). Toxicokinetics and metabolisms of benzophenone-type UV filters in rats. Toxicology. 248:89–95.

Johansen J.D., Frosch P.J., Lepoittevin J-P (Ed.) (2011). Contact Dermatitis. Springer-Verlag Berlin Heidelberg 2011.

Jubeaux G, Simon R, Salvador A, Quéau H, Chaumont A and Geffard O. (2012). Vitellogenin-like proteins in the freshwater amphipod Gammarus fossarum (Koch, 1835): Functional characterization through reproductive process, potential for use as an indicator for oocyte quality and endocrine disruption biomarkers. Aquat. Toxicol. 112-113:72-82 (as reported in ECHA, 2014A).

Karlsson I., Vanden Broecke K., Mårtensson J., Goossens A., Börje A. (2011). Clinical and experimental studies of octocrylene's allergenic potency. Contact Dermatitis, 2011 Jun;64(6):343-52

Kenney GE, Sakr A, Lichtin JL, Chou H, Bronaugh RL. (1995). *In vitro* skin absorption and metabolism of Padimate-O and a nitrosamine formed in Padimate-O-containing cosmetic products. J. Soc. Cosmet. Chem. 46:117-127.

Kerr A.C. (2010). A survey on the availability of sunscreen filters in the UK. Clinical and Experimental Dermatology. 36:541-543.

Kim S. and Choi K. (2014). Occurrences, toxicities, and ecological risks of benzophenone-3, a common component of organic sunscreen products: a mini-review. Environ Int. 70:143-57.

Kirk Othmer (2005). Paint. Volume 17. Encyclopedia of Chemical Technology. Published online 23 September 2005. Accessed October 2013.

KOKO (Kosmetik Konzept KOKO GmbH & Co. KG) (2010). Sun protection: on the efficiency of UV filters. Abailable at: http://www.dermaviduals.com/cms/upload/Publikationen_english/KP-02-10-Sonnenschutz-engl.pdf (accessed January 2015).

Köhler, K., Simmendinger, P., Roelle, W., Scholz, W., Valet, A. and Slongo, M. (2010). Paints and Coatings, 4. Pigments, Extenders, and Additives. Ullmann's Encyclopedia of Industrial Chemistry.

Krause M., Klit A., Jensen M.B., Søeborg T., Frederiksen H., Schlumpf M., Lichtensteiger W,. Skakkebaek N.E., Drzewiecki K. T. (2012). Sunscreens: are they beneficial for health? An overview of endocrine disrupting properties of UV-filters. International Journal of Andrology. 35:424-436.

Kunz PY & Fent K. (2006). Multiple hormonal activities of UV filters and comparison of *in vivo* and *in vitro* estrogenic activity of ethyl-4-aminobenzoate in fish. Aquat Toxicol.79(4):305-24
Kunz,PY, Galicia HF, Fent K. (2006). Comparison of *in vitro* and *in vivo* estrogenic activity of UV filters in fish. Toxicological Sciences. 90:349-361
Lassen, C., Hansen, C.H., Mikkelsen, S.H., Maag, J. (2005). Siloxanes – Consumption, toxicity and alternatives. Environmental Project No. 103. Danish EPA, Copenhagen.Lapczynski A, McGinty D, Jones L, Letizia CS, Api AM. (2007). Fragrance material review on ethyl hexyl salicylate. Food Chem Toxicol. 45 Suppl 1:S393-6.

Lautenschläger H. (2010). Sun protection: on the efficiency of UV filters. Kosmetische Praxis 2010 (2):10-13.

León Z, de Vlieger J, Chisvert A, Salvador A, Lingeman H, Irth H, Giera M (2010). Identification of the Biotransformation Products of 2-Ethylhexyl 4-(N,N-Dimethylamino)benzoate. Chromatographia. 71(1-2):55-63.
Liebert, M.A. (1983). Final Report on the Safety Assessment of Benzophenones-1, 3, 4, 5, 9, and 11. International Journal of Toxicology. 2:35.

Loraine G.A. and Pettigrove M.E. (2006). Seasonal variations in concentrations of pharmaceuticals and personal care products in drinking water and reclaimed wastewater in southern California. Environ Sci Technol. 40(3):687-95.

Miljødirektoratet (2014). Thomas K, Schlabach M, Langford K, Fjeld E, Øxnevad S, Rundberget T, Bæk K, Rostkowski P, and Harju M. Screening program 2013. Nye bisfenoler, organiske peroksider, fluorerte siloksaner, UV-filtre og utvalgte PBT stoffer. M-176/2014.

Monti D, Brini I, Tampucci S, Chetoni P, Burgalassi S, Paganuzzi D, Ghirardini A. (2008). Skin permeation and distribution of two sunscreens: a comparison between reconstituted human skin and hairless rat skin. Skin Pharmacol Physiol. 21:318–325.

Nagtegaal M, Ternes T, Baunmann W, Nagel R. (1997). UV-Filtersubstanzen in Wasser und Fischen. UWSF - Z. Umweltchem. Ökotox. 9(2):79-86.

NaturaLux™ (2014). UV radiation and fading. Abailable at: http://www.naturalux.com/NaturaLux_Lighting_Filters_Fading.htm (accessed September 2014).

NICNAS (1996). Mexoryl SX Active Ingredient. National Industrial Chemicals Notification and Assessment Scheme, File No: NA/399, September.

Nordic Council of Ministers (2012). Existing Default Values and Recommendations for Exposure Assessment. A Nordic Exposure Group Project 2011. TemaNord 2012:505.

OECD. (2013). OECD SIDS Assessment Profile: Titanium dioxide. Available at: http://webnet.oecd.org/Hpv/UI/SIDS_Details.aspx?id=A588D52F-5B75-4461-BB26-0572589EE13C (accessed January 2015).

Poiger T., Buser H.R., Balmer M.E., Bergqvist P.A., Müller M.D. (2004). Occurrence of UV filter compounds from sunscreens in surface waters: regional mass balance in two Swiss lakes. Chemosphere. 55(7):951-63.

Poulsen, P.B. og Schmidt, A. (2007). Kortlægning og sundhedsmæssig vurdering af kosmetiske produkter til børn. Kortlægning af kemiske stoffer i forbrugerprodukter, Nr. 88, 2007, Miljøstyrelsen.

Poulsen, P.B. og Strandesen, M. (2011). Kortlægning og sundhedsmæssig vurdering af kosmetiske produktermarkedsført som "ikke konserverede". Kortlægning af kemiske stoffer i forbrugerprodukter, Nr. 111, 2011, Miljøstyrelsen.

Rastogi S.C. (2002). UV filters in sunscreen products – a survey. Contact Dermatitis. 46:348-351.

Rothe, H. Fautz, R., Gerber, E., Neumann L., Rettinger, K., Schuh, W., Gronewold, C. (2011). Special aspects of cosmetic spray safety evaluations: Principles on inhalation risk assessment. Toxicology Letters 205: 97-104.

SCC (2000). Reports of the Scientific Committee on Cosmetology (ninth series): S13 2-Ethylhexylsalicylate. European Commission. Available at: http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/scc_o_9.pdf (accessed December 2014).

SCCNFP (2000). Opinion of the scientific committee on cosmetic products and non-food products intended for consumers concerning Titanium dioxide Colipa no S75. SCCNFP/0005/98. Available at: http://ec.europa.eu/health/ph_risk/committees/sccp/documents/out135_en.pdf (accessed December 2014).

SCCP (2006). Opinion on Benzophenone-3 Colipa no. S38. SCCP/1069/06, Scientific Committee on Consumer Products, European Commission. Available at: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_078.pdf (accessed December 2014).

SCCP (2007). Opinion on Homosalate Colipa no. S12. SCCP/1086/07, Scientific Committee on Consumer Products, European Commission. Available at: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_097.pdf (accessed December 2014).

SCCP (2008a). Opinion on Benzophenone-3 Colipa no. S38. SCCP/1201/08, Scientific Committee on Consumer Products, European Commission. Available at: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_159.pdf (accessed December 2014).

SCCP (2008b). Opinion on 4-Methylbenzylidene camphor (4-MBC) Colipa n° s60. SCCP/1184/08, Scientific Committee on Consumer Products, European Commission. Available at: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_141.pdf (accessed December 2014).

SCCP (2008c). Opinion on Diethylamino hydroxybenzoyl hexyl benzoate Colipa no S83, Scientific Committee on Consumer Products, European Commission. Available at:

http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_130.pdf (accessed December 2014).

SCCS (2014). Opinion on Titanium Dioxide (nano form) Colipa no S75. SCCS/1516/13, Scientific Committee on Consumer Safety, European Commission. Available at: http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_136.pdf (accessed December 2014).

SCCS (2014). The SCCS's Memorandum on Endocrine Disruptors. SCCS/1544/14. Available at: http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_s_009.pdf

SCCS (2012). The SCCS's Notes of Guidance for the Testing of Cosmetic Substances and their Safety Evaluation, 8 th revision. SCCS/1501/12. Scientific Committee on Consumer Safety, European Commission. Available at: http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_s_006.pdf (accessed December 2014).

Schauer UM, Völkel W, Heusener A, Colnot T, Broschard TH, von Landenberg F, Dekant W (2006). Kinetics of 3-(4-methylbenzylidene)camphor in rats and humans after dermal application. Toxicol Appl Pharmacol. 216(2):339-46.

Schlumpf M., Kypke K., Wittassek M., Angerer J., Mascher H., Mascher D., Vökt C., Birchler M., Lichtensteiger W. (2010). Exposure patterns of UV filters, fragrances, parabens, phthalates, organochlor pesticides, PBDEs, and PCBs in human milk: Correlation of UV filters with use of cosmetics. Chemosphere. 81:1171–1183.

Shioda T & Wakabayashi M (2000). Evaluation of reproductivity of medaka (*Oryzias latipes*) exposed to chemicals using a 2-week reproduction test. Water Sci. Technol., **42**, 53-60 (as quoted in ECHA, 2014A)

SPIN (2014). Data fra databasen "Substances in Preparations in Nordic Countries" (SPIN). Version downloaded fra: http://195.215.202.233/DotNetNuke/default.aspx

Stackelberg PE, Furlong ET, Meyer MT, Zaugg SD, Henderson AK, Reissman DB. (2004). Persistence of pharmaceutical compounds and other organic wastewater contaminants in a conventional drinking-water-treatment plant. Sci Total Environ. 329(1-3):99-113.

Søeborg T, Basse LH, Halling-Sørensen B. (2007). Risk assessment of topically applied products. Toxicology. 236(1-2):140-8.

UV (2011a). UV Degradation & Stabilization of Industrial Products. Chapter 8 in: Handbook of UV Degradation and Stabilization. Editor: George Wypych, ChemTec Publishing.

UV (2011b). UV stabilizers. Chapter 4 in: Handbook of UV Degradation and Stabilization. Editor: George Wypych, ChemTec Publishing.

Völkel W, Colnot T, Schauer UM, Broschard TH, Dekant W. (2006). Toxicokinetics and biotransformation of 3-(4-methylbenzylidene)camphor in rats after oral administration. Toxicol Appl Pharmacol. 216(2):331-8.

WHO (2014). The known health effects of UV. Ultraviolet radiation and the INTERSUN Programme. Available at: http://www.who.int/uv/faq/uvhealtfac/en/ (accessed September 2014).

Ye Y. & King III R.E. (2006). Additives for Polyolefin Film Products: An overview of Chemistry and Effects. Available at: http://www.tappi.org/content/enewsletters/eplace/2006/06PLA04.pdf (accessed January 2015).

Zenker A, Schmutz H, Fent K. (2008). Simultaneous trace determination of nine organic UV-absorbing compounds (UV filters) in environmental samples. J Chromatogr A. 1202(1):64-74.

Zweifel H, Maier R-D, Schiller M (Eds.). (2009). Plastics Additives Handbook. Carl Hanser Verlag, Munich, 6th ed.

Appendix 1: List of UV filters allowed in cosmetic products (EU Cosmetics Regulation Appendix 6) and their registration status under REACH as well as registrations in the SPIN database

The list below includes UV filters permitted in cosmetic products (EU Cosmetics Regulation Appendix 6). The column with the highest concentration in the product ready-to-use specifies the maximum concentration under the Cosmetics Regulation.

ECHA registration status indicates the total registered production + import of substances in the EU of the registered substances. For substances not registered, it is indicated whether they are pre-registered. The registered uses, as indicated in the table, are the uses which include a chemical product category (PC) in the registrations, meaning that the substances are used in chemical products. Product categories include products used by both professionals and consumers. Industrial applications stated as a chemical product category or process categories (PROC) in the registrations thus are not included in the table, as they are deemed not to give rise to significant consumer exposure. It should be noted that if a product category is mentioned, itdoes not necessarily mean that the substances are actually used in these products.

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
2	N,N,N-Trimethyl-4-(2-oxoborn-3-ylidenemethyl) anilinium methyl sulfate	Camphor benzalkonium methosulfate	52793-97-2	258-190-8	6%	Pre-registered	-	No notifications
3	2-Hydroxybenzoic acid 3,3,5-trimethylcyclohexyl ester / Homosalate	Homosalate	118-56-9	204-260-8	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products	No notifications
4	(2-hydroxy-4-methoxyphenyl)(phenyl)methanone Oxybenzone	Benzophenone-3	131-57-7	205-031-5	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products PC 9a: Coatings and	Paint and varnish, construction materials

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
							paints, thinners, paint removers PC 9b: Fillers, putties, plasters, modelling clay PC 9c: Finger paints PC 32: Polymer preparations and compounds	
6	2-phenyl-1H-benzimidazole-5-sulphonic acid/ Ensulizole	Phenylbenzimidazole sulphonic acid	27503-81-7	248-502-0	8% (as acid)	100 – 1000 t/year	PC 39: Cosmetics, personal care products	Notified but no information on uses
7	3,3'-(1,4-Phenylenedimethylene)bis[7,7-dimethyl-2-oxo-bicyclo[2.2.1]heptane-1-methanesulfonic acid] and salts hereof, Ecamsule	Terephthalylidene dicamphor sulfonic acid	92761-26-7 / 90457-82-2	410-960-6 / -	10% (as acid)	Pre-registered	-	No notifications
8	1-[4-(1,1-Dimethylethyl)phenyl]-3-(4-methoxyphenyl)propane-1,3-dione / Avobenzone	Butyl methoxydibenzoyl-methane	70356-09-1	274-581-6	5%	1000 – 10,000 t/year	PC 39: Cosmetics, personal care	No notifications

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
							products PC 28: Perfumes, fragrances.	
9	alpha-(2-Oxoborn-3-yliden)toluen-4-sulphonic acis and salts hereof	Benzylidene camphor sulfonic acid	56039-58-8	-	6% (as acid)	Neither registered nor pre-registered	-	No notifications
10	2-Propenoic acid, 2-cyano-3,3-diphenyl-, 2-ethylhexyl ester / Octocrilene	Octocrylene	6197-30-4	228-250-8	10% (as acid)	1000 – 10,000 t/year	PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances, PC 9a: Coatings and paints, thinners, paint removers, PC 9b: Fillers, putties, plasters, modelling clay, PC 21: Laboratory chemicals, PC 29: Pharmaceuticals PC 30:	Notified but no information on uses

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
							Photo-chemicals, PC 32: Polymer preparations and compounds	
11	Polymer af N-{(2 og 4)-[(2-oxoborn-3-ylidene)methyl]benzyl}acrylamide	Polyacrylamido-methyl benzyliden camphor	113783-61-2	-	6%	Neither registered nor pre-registered	-	No notifications
12	2-Ethylhexyl 4-methoxycinnamate / Octinoxate	Ethylhexyl methoxycinnamat	5466-77-3	226-775-7	10%	1000 – 10,000 t/year	PC 21: Laboratory chemicals, PC 28: Perfumes, fragrances, PC 29: Pharmaceuticals, PC 30: Photo-chemicals, PC 39: Cosmetics, personal care products.	Notified but no information on uses
13	Ethoxylated ethyl-4-aminobenzoate	PEG-25 PABA	116242-27-4	-	10%	Neither registered nor pre-registered	-	No notifications

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
14	Isopentyl-4-methoxycinnamate / Amiloxat	Isoamyl p-methoxycinnamate	71617-10-2	275-702-5	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products.	No notifications
15	2,4,6-Trianilino-(p-carbo-2'-ethylhexyl-1'-oxy)-1,3,5-triazine	Ethylhexyl triazone	88122-99-0	402-070-1	5%	100 – 1000 t/year 10-100 t/year	PC 39: Cosmetics, personal care products.	Notified but no information on uses
16	Phenol, 2-(2H-Benzotriazol-2-yl)-4-Methyl-6-(2-Methyl-3-(1,3,3,3-Tetramethyl-1-(Trimethylsilyl)Oxy)-Disiloxanyl)Propyl	Drometrizole trisiloxane	155633-54-8	-	15%	Pre-registered	-	No notifications
17	4,6-Bis[4-(2-ethylhexyloxycarbonyl)anilino]-2-[4-(tert-butylaminocarbonyl)anilino]-1,3,5-triazine / Iscotrizinol (USAN	Diethylhexyl butamido triazone	154702-15-5	-	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products.	No notifications
18	3-(4'-Methylbenzyliden)-d-1-camphor (4-methylbenzylidine camphor) /enzacamene	4-methylbenzylidene camphor	38102-62-4 / 36861-47-9	253-242-6 /	4%	Pre-registered	-	No notifications
19	1,7,7-trimethyl-3-	3-benzylidene camphor[37]	15087-24-	239-139-	2%	Pre-registered	-	No

[37] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
	(phenylmethylene)bicyclo[2.2.1]heptan-2-one		8	9				notifications
20	2-Ethylhexyl salicylate / Octisalat	Ethylhexyl salicylate	118-60-5	204-263-4	5%	100 – 1000 t/year	PC 28: Perfumes, fragrances, PC 39: Cosmetics, personal care products	No notifications
21	2-Ethylhexyl 4-(dimethylamino)benzoate / Padimat O (USAN:BAN)	Ethylhexyl dimethyl paba	21245-02-3	244-289-3	8%	Pre-registered	-	Notified but no information on uses
22	2-hydroxy-4-methoxybenzophenone-5-sulfonic acid (Benzophenone-5) sodium salts hereof / Sulisobenzone	Benzophenone-4; benzophenone-5	4065-45-6 / 6628-37-1	223-772-2 / -	5% (as acid)	Pre-registered	-	No notifications
23	2,2'-Methylenbis(6-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol) / Bisoctrizol	Methylen bis-benzotriazolyl tetramethylbutyl-phenol	103597-45-1	403-800-1	10%	100 + t/year, Six single registrations 0-10 t/year	Ingen PC SU 12: Manufacture of plastics products, including compounding and conversion SU 11: Manufacture of	Notified but no information on uses

No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
							rubber products	
24	Sodium salt of 2,2'-bis(1,4-phenylen)-1H-benzimidazole-4,6-disulfonic acid / Bisdisulizol disodium (USAN)	Disodium phenyl dibenzimidazole tetrasulfonate	180898-37-7	429-750-0	10% (as acid)	10 – 100 t/year	PC 28: Perfumes, fragrances, PC 39: Cosmetics, personal care products	No notifications
25	2,2'-(6-(4-Methoxyphenyl)-1,3,5-triazin-2,4-diyl)bis(5-((2-ethylhexyl)oxy)phenol) / Bemotrizinol	Bis-ethylhexyloxy-phenol methoxyphenyl triazin	187393-00-6		10%	10 – 100 t/year	PC 21: Laboratory chemicals, PC 39: Cosmetics, personal care products	No notifications
26	Dimethicodiethylbenzal malonate	Polysilicone-15	207574-74-1	426-000-4	10%	Pre-registered	-	No notifications
27	Titanium dioxide (2)	Titanium dioxide	13463-67-7 / 1317-70-0 / 1317-80-2	236-675-5 /205-280-1 / 215-282-2	25%	1,000,000–10,000,000 t/year	Wide range of product and article categories *2.	Paint, lacquers and varnishes (water based and organic); filling material; Cement, concrete,

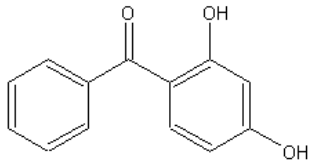
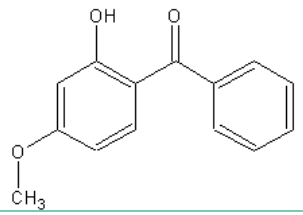
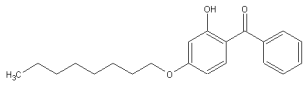
No.	Chemical name	Glossary of common ingredient names	CAS No.	EC no.	Highest conc. in ready-to-use product	ECHA registration status	Registered uses	SPIN registered uses in DK *1
								mortar; fillers; other colorants; putty compound
28	Hexyl 2-(1-(diethylaminohydroxyphenyl)methanoyl) benzoate	Diethylamino hydroxybenzoyl hexyl benzoate	302776-68-7	443-860-6	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products	Notified but no information on uses
29	1,3,5-triazine, 2,4,6-tris [1,1′-bifenyl]-4-yl-, including the nanomaterial	Tris-biphenyl triazine tris-biphenyl triazine (nano)	31274-51-8	-	10%	100 – 1000 t/year	PC 39: Cosmetics, personal care products	No notifications

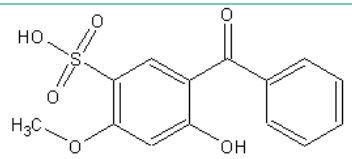
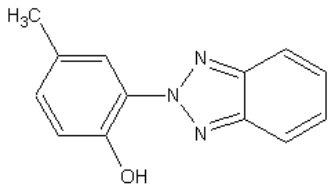
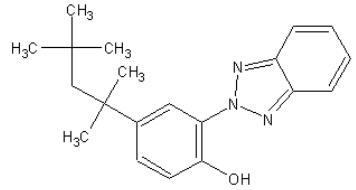
*1 As registered for Denmark in 2012 in the SPIN database as data from the Nordic Product Registers (http://195.215.202.233/DotNetNuke/default.aspx)

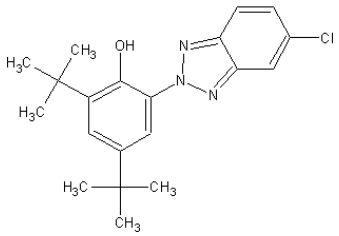
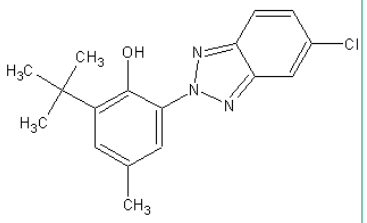
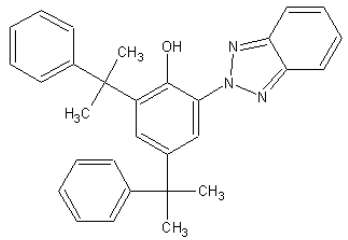
*2 PC 1: Adhesives, sealants, PC 2: Adsorbents, PC 3: Air care products, PC 4: Antifreeze and de-icing products, PC 7: Base metals and alloys, PC 8: Biocidal products, PC 9b: Fillers, putties, plasters, modelling clay, PC 9a: Coatings and paints, thinners, paint removers, PC 9c: Finger paints, PC 12: Fertilizers, PC 11: Explosives, PC 13: Fuels, PC 14:Metal surface treatment products, including galvanic and electroplating products , PC 15: Non-metal-surface treatment products, PC 16: Heat transfer fluids, PC 17: Hydraulic fluids, PC 18: Ink and toners, PC 19: Intermediate, PC 20: Products such as ph-regulators, flocculants, precipitants, neutralization agents , PC 21: Laboratory chemicals, PC 23: Leather tanning, dye, finishing, impregnation and care products, PC 24: Lubricants, greases, release products, PC 25: Metal working fluids, PC 26: Paper and board dye, finishing and impregnation products: including bleaches and other processing aids, PC 27: Plant protection products, PC 28: Perfumes, fragrances, PC 29: Pharmaceuticals, PC 30: Photo-chemicals, PC 31: Polishes and wax blends, PC 32: Polymer preparations and compounds, PC 33: Semiconductors, PC 34: Textile dyes, finishing and impregnating products; including bleaches and other processing aids, PC 35: Washing and cleaning products (including solvent based products), PC 36: Water softeners, PC 37: Water treatment chemicals, PC 38: Welding and soldering products (with flux coatings or flux cores.), flux products, PC 39: Cosmetics, personal care products, PC 40: Extraction agents, PC 0: Other: PC 6: automotive care products; PC 5: artists supply and hobby preparations, PC 10: buildings and construction preparations.

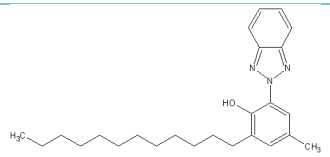
Appendix 2: Information on UV filters and UV absorbers from Internet sources

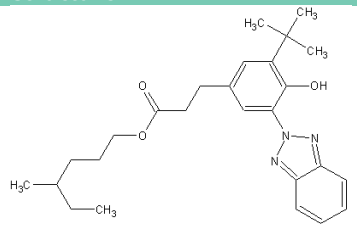
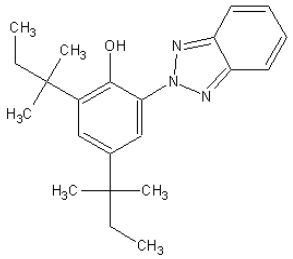
The following table contains information from Internet sources on UV filters and UV absorbers with uses other than (or in addition to) cosmetics.

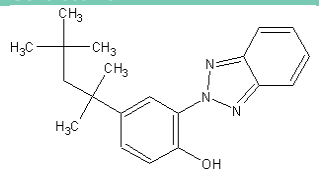
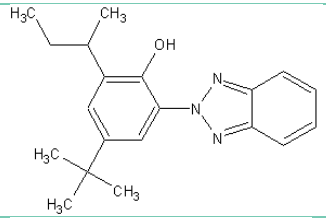
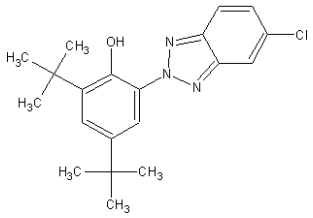
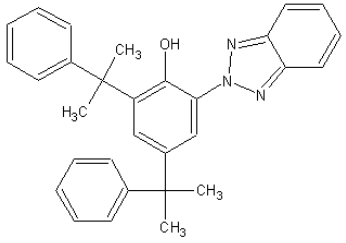
CAS	Active ingredient	Smiles	Structure	Information on uses
Benzophenone-type				
131-56-6	2,4-Dihydroxybenzophenone (or 2,4-dihydroxyphenyl)-phenyl-methanone)	C1=CC=C(C=C1)C(=O)C2=C(C=C(C=C2)O)O		**Information from internet:** Suppliers: Clariant Additives and Addivant. Trade names/registered trade marks: Hostavin 3041, Lowilite 24. Uses: Used in water borne coatings, wood coatings and general industrial coatings. **Information on ECHA dissemination database:** Joint registration at 0-10 t/year level. Identified uses includes polymer preparations and compounds (PC32), and in cosmetics/personal care products (PC39)
131-57-7	Oxybenzone 2-Hydroxy-4-methoxy benzophenone	COC1=CC(=C(C=C1)C(=O)C2=CC=CC=C2)O		**Information from internet:** Suppliers: Addivant. Trade names/registered trade marks: LOWILITE 20. **Information on ECHA dissemination database:** Joint registration at 10-100 t/year level. Identified use is in cosmetics/personal care products (PC39).
1843-05-6	Octabenzone (2-hydroxy-4-octoxy-phenyl)-phenyl-methanone	CCCCCCCCOC1=CC(=C(C=C1)C(=O)C2=CC=CC=C2)O		**Information from internet:** Suppliers: BASF, Addivant and Clariant Additives. Trade names/registered trade marks: CHIMASSORB® 81, Lowilite 22, Hostavin ARO 8 Gran, Hostavin ARO 8 Pwd. Uses: Reported to be used in a range of solvent borne coatings (industrial and architectural), adhesives and sealants. Also reported to be used in polymers, including polyolefins. **Information on ECHA dissemination database:** Joint registration at 1,000-10,000 t/year level. Trade names/registered trade marks: Cyasorb® UV-531 Light Absorber Identified uses include adhesives (PC1), coatings (PC9a), polymers (including polyurethanes, polyurethane foams and rubber; PC32). Consumer uses given include adhesives, coatings and inks,

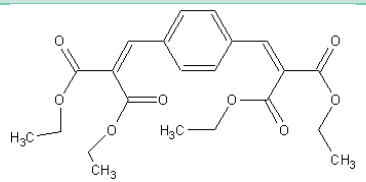
CAS	Active ingredient	Smiles	Structure	Information on uses
				along with adsorbents (PC2), air care products (PC3) and de-icing products (PC4). Also present in rubber and plastic articles (AC10 and AC13).
4065-45-6	Sulisobenzone 5-Benzoyl-4-hydroxy-2-methoxy benzenesulfonic acid 2-Hydroxy-4-methoxy benzophenone-5-sulfonic acid	COC1=C(C=C(C(=C1)O)C(=O)C2=CC=CC=C2)S(=O)(=O)O		**Information from internet:** Suppliers: Addivant. Trade name/registered trade mark: Lowilite 20S. **Information on ECHA dissemination database:** Joint registration at 1,000-10,000 t/year level. Identified uses include cosmetics/personal care products (PC39) including liquids, sprays, foams and gels, along with as a laundry additive. Other uses include polishes and wax blends (PC31), washing and cleaning products (PC35) and air freshener aerosols, and medical devices and health products (PC29).
Benzotriazole-types				
2440-22-4	2-(2H-benzotriazol-2-yl)-p-cresol	CC1=CC(=C(C=C1)O)N2N=C3C=CC=CC3=N2		**Information from internet:** Suppliers: BASF and Addivant. Trade names/registered trade marks: TINUVIN P and Lowilite 55. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. Other uses include polymers (e.g. ABS, HIPS, PVC). **Information on ECHA dissemination database:** Joint registration at 1,000-10,000 t/year level. Trade names/registered trade marks: Uvasorb SV. Identified uses include adhesives (PC1), coatings and inks (PC9a and PC9b) as well as polymers (PC32; including polyurethanes and rubber). Consumer uses include coatings, adhesives and polyurethanes. Also present in rubber and plastic articles (AC10 and AC13).
3147-75-9	2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetra methylbutyl)phenol	CC(C)(C)CC(C)(C)C1=CC(=C(C=C1)O)N2N=C3C=CC=CC3=N2		**Information from internet:** Suppliers: BASF. Trade name/registered trade marks: TINUVIN 329. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Trade names/registered trade marks: UV-5411, UV-329. Identified uses include rubber and polymers (PC32) and use in polymerisation and polycondensation reactions. Present in rubber and plastic articles (AC10 and AC13).

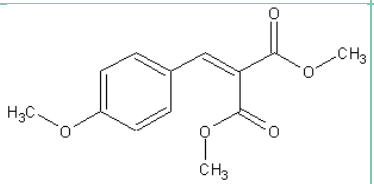
CAS	Active ingredient	Smiles	Structure	Information on uses
3864-99-1	2,4-di-tert-butyl-6-(5-chlorobenzotriazol-2-yl) phenol	CC(C)(C)C1=CC(=C(C(=C1)N2N=C3C=CC(=CC3=N2)Cl)O)C(C)(C)C		**Information from internent:** Suppliers: not identified. **Information on ECHA dissemination database:** Pre-registered substance.
3896-11-5	Bumetrizole 2-(2'-Hydroxy-3'-t-butyl-5'-methyl phenyl)-5-chloro benzotriazole	CC1=CC(=C(C(=C1)N2N=C3C=CC(=CC3=N2)Cl)O)C(C)(C)C		**Information from internet:** Suppliers: Addivant, Clariant Additives and BASF Trade names/registered trade marks: Lowilite 26, Hostavin 3326 powder, TINUVIN 326. Uses: Used in solvent borne coatings, wood coatings and general industrial coatings. Also used in plastics (e.g. polyolefins). The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Identified uses include rubber and polymers (plastics and foams) (PC32) Also used in adhesives/sealants (PC1) and coatings (PC9a). Industrial uses of adhesives include paper and transport. Consumer use reported in coatings, adhesive and printing inks. Present in rubber and plastic articles (AC10 and AC13).
70321-86-7	2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol	CC(C)(C1=CC=CC=C1)C2=CC(=C(C(=C2)N3N=C4C=CC=CC4=N3)O)C(C)(C)C5=CC=CC=C5		**Information from internet:** Suppliers: BASF. Trade names/registered trade marks: TINUVIN 234. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Identified uses include rubber and polymers (plastics (including polyurethane and rigid and flexible foams) (PC32) and polycondensation and polymerisation reactions. Also used in adhesives, coatings and paints (designated PC9a in the registration). Consumer use reported in coatings, adhesive and printing inks. Present in plastic articles (AC13).
103597-45-1	2,2'-methylenebis(6-(2H-benzotriazol-2-yl)-4-1,1,3,3-			**Information from internet**: Suppliers: BASF Trade name/registered trade mark: TINUVIN 360.

CAS	Active ingredient	Smiles	Structure	Information on uses
	tetramethylbutyl)phenol)			Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Joint registration at >100 t/year level. Six individual registrations: 1-10 t/year Trade names/registered trade marks: EVERSORB 78, LOWILITE 36, LS.BT.620, MIXXIM BB/100, TINUVIN 360, UV-360. Identified use is in polymers and resins (PC32).
104810-48-2	Poly(oxy-1,2-ethanediyl), α-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-ω-hydroxy- [3-[3-(2H-Benzotriazol-2yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-hydroxypoly(oxo-1,2-ethanediyl			**Information from internet**: Suppliers: BASF Trade name/registered trade mark: TINUVIN 1130. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Pre-registered substance.
125304-04-3	Phenol, 2-(2H-benzotriazol-2-yl)-6-dodecyl-4-methyl-, branched and linear	CCCCCCCCCCCCC1=C(C(=CC(=C1)C)N2N=C3C=CC=CC3=N2)O		**Information from internet**: Suppliers: BASF Trade name/registered trade mark: TINUVIN 571. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Pre-registered substance.

CAS	Active ingredient	Smiles	Structure	Information on uses
127519-17-9	A mixture of branched and linear C7-C9 alkyl 3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]propionates Benzenepropanoic acid, 3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy-, C7-9-branched and linear alkyl esters	CCC(C)CCCOC(=O)CCC1=CC(=C(C(=C1)N2N=C3C=CC=CC3=N2)O)C(C)(C)C		**Information from internet**: Suppliers: BASF Trade name/registered trade mark: TINUVIN 384-2, TINUVIN 99-2. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Registration at >1 t/year level. Trade names/registered trade marks: CGL 384; TINUVIN 384. Stated to be a new liquid UV absorber developed for coatings. Articles include automotive, wood and plastics articles.
25973-55-1	2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol 2-(2´-Hydroxy-3',5'-di-t-amylphenyl) benzotriazole	CCC(C)(C)C1=CC(=C(C(=C1)N2N=C3C=CC=CC3=N2)O)C(C)(C)CC		**Information from internet**: Suppliers: BASF and Addivant. Trade names/registered trade marks: TINUVIN 328 and Lowilite 28. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. Also used in polymers (e.g. ABS, HIPS, PVC, polyesters, polycarbonates, polyacetals and polymethylmethacrylate, polyvinylbutyral) and polyurethane fibres. **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Identified uses include polymers (including polyurethanes and rigid and flexible foams) (PC32) and polymerisation an polycondensation reactions. Also used in adhesives/sealants (PC1) and coatings (PC9a). Industrial uses of adhesives include paper and transport. Consumer use reported in coatings, adhesive and printing inks. Present in plastic articles (AC13).
25973-55-5 (may not be the correct CAS Number)	Not known	Not known		**Information from internet:** Suppliers: Clariant Additives. Trade name/registered trade mark: Hostavin 3310 powder. Uses: Car refinishes, automotive OEM, solvent borne coatings, wood coatings and general industrial coatings. Also used in plastics. **Information on ECHA dissemination database:** Not listed.

CAS	Active ingredient	Smiles	Structure	Information on uses
3147-75-9	2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetra methylbutyl)phenol	CC(C)(C)CC(C)(C)C1=CC(=C(C=C1)O)N2N=C3C=CC=CC3=N2		**Information from internet:** Suppliers: Addivant. Trade name/registered trade mark: LOWILITE 29. Uses: Used in polymers, particularly polyesters and polycarbonates. **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Trade names/registered trade marks: UV-5411, UV-329. Identified uses include polymers and coatings (PC32). Present in plastic and rubber articles (AC10 and AC13).
36437-37-3	2-(2-Hydroxy-3-sec-butyl-5-t-butyl phenyl)benzotriazole	CCC(C)C1=C(C(=CC(=C1)C(C)(C)C)N2N=C3C=CC=CC3=N2)O		**Information from internet:** Suppliers: Not identified. **Information on ECHA dissemination database:** Pre-registered substance.
3864-99-1	2-(2´-Hydroxy-3',5'-di-t-butylphenyl)-5-chlorobenzotriazole	CC(C)(C)C1=CC(=C(C(=C1)N2N=C3C=CC(=CC3=N2)Cl)O)C(C)(C)C		**Information from internet:** Suppliers: Addivant. Trade name/registered trade mark: LOWILITE 27. Uses: Used in polymers (e.g. polystyrene, ABS, polyolefins). **Information on ECHA dissemination database:** Pre-registered substance.
70321-86-7	2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol 2-(2-Hydroxy-3,5-di(1,1-dimethyl benzyl)-2H-benzotriazole	CC(C)(C1=CC=CC=C1)C2=CC(=C(C(=C2)N3N=C4C=CC=CC4=N3)O)C(C)(C)C5=CC=CC=C5		**Information from internet:** Suppliers: Clariant Additives and Addivant Trade names/registered trade marks: Hostavin 3315 and Lowilite 234. Uses: Car refinishes, liquid industrial coatings of all types and plastic coatings. Also used in polymers (polycarbonate, nylon, polyamides, polyesters, PVC etc.). **Information on ECHA dissemination database:** Joint registration at 100-1,000 t/year level. Identified uses include rubber and polymers (including polyurethanes and rigid and flexible foams) (PC32). Also used in coatings, adhesives and printing inks. Consumer use reported in coatings, adhesive and printing inks. Present in rubber and plastic articles (AC10 and AC13).

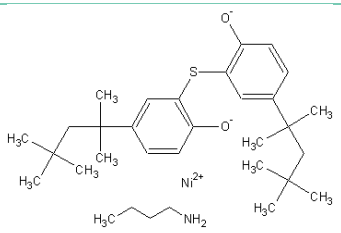
CAS	Active ingredient	Smiles	Structure	Information on uses
73936-91-1	2-(2H-Benzotriazol-2-yl)-6-(1-methyl-1-phenylethyl)-4-(1,1,3,3-tetra methylbutyl)phenol			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 928. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** One individual registration: 1-10 t/year. Trade names/registered trade marks: Chiguard 5228. Identified uses include paints and coatings (PC9a and PC32). Articles include vehicles (AC1).
Not given	Not given			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 171. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Not searched.
Mixture of: 104810-48-2 (52%), 104810-47-1 (35%) and 25322-68-3 (13%)	Reaction products of methyl 3-(3-(2H-benzotriazole-2-yl)-5-t-butyl-4-hydroxy phenyl) propionate/ PEG 300			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 213. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** CAS 104810-48-2 and 104810-47-1 are both pre-registered substances. 25322-68-3 is registered under a joint registration at 100-1000 t/y. Identified uses includes polymer preparations and compounds (PC32), washing and cleaning products (PC35), pharmaceuticals (PC29) and cosmetics/personal care products.
Benzylidene malonate-types				
6337-43-5	tetraethyl 2,2'-(1,4-phenylenedimethylidyne)bismalonate diethyl 2-[[4-[2,2-bis(ethoxycarbonyl)ethe	CCOC(=O)C(=CC1=CC=C(C=C1)C=C(C(=O)OCC)C(=O)OCC)C(=O)OCC		**Information from internet:** Suppliers: Clariant Additives. Trade name/registered trade mark: Hostavin B-CAP Pwd TP Uses: Used in polymers. **Information on ECHA dissemination database:** Pre-registered substance.

CAS	Active ingredient	Smiles	Structure	Information on uses
	nyl]phenyl]methylidene] propanedioate			
7443-25-6	dimethyl 2-[(4-methoxyphenyl)methylidene]propanedioate	COC1=CC=C(C=C1)C=C(C(=O)OC)C(=O)OC		**Information from internet:** Suppliers: Clariant Additives. Trade name/registered trade mark: Hostavin PR-25 Gran and Hostavin PR-25 Pwd Uses: Used in polymers (including PVC) and industrial and solvent borne coatings. **Information on ECHA dissemination database:** Pre-registered substance.
Carbon black				
1333-84-4	Carbon black			**Information from internet:** Uses: Traditionally, carbon black has been used as a reinforcing agent in tires. Other uses include acting as a pigmenting, UV stabilizing and conductive agent in a variety of common and specialty products, including plastics (widely used for plastic masterbatch applications, such as conductive packaging, films, fibres, moldings, pipes and semi-conductive cable compounds) and coatings (provides pigmentation, conductivity and UV protection for a number of coating applications including marine, aerospace and industrial). **Information on ECHA dissemination database:** Joint registration at 1,000,000-10,000,000 t/year level covering 89 registrants, one individual registration at the 1,000-10,000 t/year level and one individual registration at the 100,000-1,000,000 t/year level.

CAS	Active ingredient	Smiles	Structure	Information on uses
Triazine-types				
137658-79-8	2-(4,6-bis(2,4-dimethylphenyl)-1,3,5-triazin-2-yl)-5-(3-((2-ethylhexyl)oxy)-2-hydroxypropoxy)phenol 2-[4-[(2-Hydroxy-3-(2'-ethyl)hexyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 405. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Two individual registrations. 1-10 t/year Trade names/registered trade marks: Eversorb 45, Chiguard 5405. Identified uses: Used in automotive clear coats, automotive powder clear coats, powder coatings for plastics and wood and high performance industrial coatings (PC9a, PC32). Article categories: AC1: Vehicles, AC2: Machinery, mechanical appliances, electrical/electronic articles, AC11: Wood articles, AC13: Plastic articles.

CAS	Active ingredient	Smiles	Structure	Information on uses
147315-50-2	2-(4,6-Diphenyl-1,3,5-triazin-2-yl)-5-((hexyl)oxy)-phenol			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 1577 ED. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Joint registration at >100 t/year. Three individual registrations: 1-10 t/year Identified uses: Plastics, foamed polymers and polymer coatings (PC32). Also used in polymerisation and polycondensation processes. Present in plastic articles (AC13). Two registrants gave other uses (including consumer uses) in adhesives/sealants (PC1), metal surface treatment products (PC14), non-metal surface treatment products (PC15), inks and toners (PC18), textile dyes or finishing products (PC34) and coatings/paints (PC9a). The same registrant gives the following article categories: AC 1: Vehicles, AC 2: Machinery, mechanical appliances, electrical/electronic articles, AC 3: Electrical batteries and accumulators, AC 5: Fabrics, textiles and apparel, AC 7: Metal articles, AC 8: Paper articles, AC 11: Wood articles, AC 13: Plastic articles and AC 38: Packaging material for metal parts, releasing grease/corrosion inhibitors along with AC01: Other (non intended to be released) and Other (non intended to be released): AC1-1, AC11-1, AC11-2, AC1-2, AC12-1, AC3-1, AC3-2, AC3-3, AC12-2.

CAS	Active ingredient	Smiles	Structure	Information on uses
153519-44-9	1,3-Benzenediol, 4-[4,6-bis(2,4-dimethylphenyl)-1,3,5-triazin-2-yl]-, reaction products with 2-[(dodecyloxy)methyl]oxirane and 2-[(C10-16-alkyloxy)methyl]oxirane Mixture of 2-[4-[(2-Hydroxy-3-dodecyloxypropyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine and 2-[4-[(2-Hydroxy-3-tridecyloxypropyl)oxy]-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 400. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Two individual registrations. 1-10 t/year. Trade names/registered trade marks: Eversorb SV40N Identified uses (by one registrant): Coatings and paints, thinners and paint removes (PC9a) as well as in polymer preparations and compounds (PC32). Same resistrant gives following article categories: AC 1: Vehicles, AC 7: Metal articles, AC 8: Paper articles, AC 11: Wood articles and AC 13: Plastic articles. No identified uses in the other registration, only one article category given (AC 0: Other: automotive, wood and plastics).
Not given	Not given			**Information from interenet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 477 DW. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Not searched.
Not given	Not given			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN 479. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent

CAS	Active ingredient	Smiles	Structure	Information on uses
				borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Not searched.
Others/unknown				
Not given	High molecular weight hindered amine stabiliser. Said to be a triazine derivative - name not given			**Information from internet:** Suppliers: BASF. Trade name/registered trade mark: TINUVIN NOR™ 371. Uses: The TINUVIN additives as a group are generally reported to be used in water and solvent borne coatings, adhesives and sealants. **Information on ECHA dissemination database:** Not searched
Not given	Blend of UV-stabilizers and antioxidant - constituents not given.			**Information from internet:** Suppliers: Addivant. Trade name/registered trade mark: Lowilite UV B1260. Uses: Used in polyurethanes in automotive and exterior applications. **Information on ECHA dissemination database:** Not searched.
Not given	Blend of UV-stabilizers and antioxidant - constituents not given.			**Information from interenet:** Suppliers: Addivant. Trade name/registered trade mark: Lowilite U B1211. Uses: Used in polyolefins and polyurethanes. **Information on ECHA dissemination database:** Not searched.
14516-71-3	(butylamine)[[2,2'-thiobis[4-(1,1,3,3-tetramethylbutyl)phenolato]](2-)-O,O',S]nickel (2,2'-Thiobis(4-tert-octyl-phenolato))-N-butylamine-Nickel (II)	CCCCN.CC(C)(C)CC(C)(C)C1=CC(=C(C=C1)[O-])SC2=C(C=CC(=C2)C(C)(C)CC(C)(C)C)[O-].[Ni+2]		**Information from interenet:** Suppliers: Addivant. Trade name/registered trade mark: Lowilite Q 84. Uses: Used in polyolefins. **Information on ECHA dissemination database:** Pre-registered substance.

Appendix 3: List of UV-absorbers in the CosIng data base and their registration status under REACH (October 2013)

No.	Substance name	CAS No.	Information in ECHA dissemination database
1.	1-(3,4-dimethoxyphenyl)-4,4-dimethyl-1,3-pentanedione (jpn)	-	Not searched (CAS Number missing)
2.	3-benzylidene camphor[38]	15087-24-8	See Appendix 1:
3.	4-methylbenzylidene camphor	36861-47-9 / 38102-62-4	See Appendix 1:
4.	Acetaminosalol	118-57-0	Substance pre-registered
5.	Aesculus turbinata seed extract	-	Not searched (CAS Number missing)
6.	Allantoin paba	4207-42-5	Not listed
7.	Benzalphthalide	575-61-1	Registered as an intermediate.
8.	Benzophenone	119-61-9	Joint registration at 1,000-10,000 t/year level. Identified uses: PC 9a: Coatings and paints, thinners, paint removes, PC 32: Polymer preparations and compounds. Also used in fragrances for PC 3: Air care products, PC 31: Polishes and wax blends and PC 35: Washing and cleaning products (including solvent-based products). Also registered as an intermediate only.
9.	Benzophenone-1	131-56-6	See Appendix 2:
10.	Benzophenone-10	1641-17-4	Substance pre-registered.
11.	Benzophenone-11	1341-54-4	Not listed.
12.	Benzophenone-12	1843-05-6	See Appendix 2:
13.	Benzophenone-2	131-55-5	Substance pre-registered.
14.	Benzophenone-3	131-57-7	See Appendix 2:
15.	Benzophenone-4	4065-45-6	See Appendix 2:
16.	Benzophenone-5	6628-37-1	See Appendix 1
17.	Benzophenone-6	131-54-4	Substance pre-registered.
18.	Benzophenone-7	85-19-8	Substance pre-registered.
19.	Benzophenone-8	131-53-3	Substance pre-registered.
20.	Benzophenone-9	76656-36-5	Substance pre-registered.
21.	Benzotriazolyl dodecyl p-cresol	125304-04-3	See Appendix 2
22.	Benzyl salicylate	118-58-1	Joint registration at 1,000-10,000 t/year. Identified uses: PC 3: Air care products, PC 8: Biocidal products (e.g. disinfectants, pest control), PC 28: Perfumes, fragrances, PC 31: Polishes and wax blends, PC 35: Washing and

[38] According to Commission Regulation (EU) 2015/1298 of 28 July 2015 amending Annexes II and VI to Regulation (EC) No 1223/2009 of the European Parliament and of the Council on cosmetic products, the entry with reference no. 19 (3-Benzylidene Camphor) is deleted

No.	Substance name	CAS No.	Information in ECHA dissemination database
			cleaning products (including solvent based products), PC 39: Cosmetics, personal care products.
23.	Benzylidene camphor sulfonic acid	56039-58-8	See Appendix 1:
24.	Benzylidenecamphor hydrolyzed collagen sulfonamide	222400-12-6	Not listed.
25.	Bis(butylbenzoate) diaminotriazine aminopropyltrisiloxane	-	Not searched (CAS Number missing)
26.	Bis-ethylhexyloxyphenol methoxyphenyl triazine	187393-00-6	See Appendix 1:.
27.	Bornelone	2226-11-1	Substance pre-registered.
28.	Bumetrizole	3896-11-5	See Appendix 2:
29.	Butyl methoxydibenzoylmethane	70356-09-1	See Appendix 1:
30.	Calcium cerium oxide	-	Not searched (CAS Number missing)
31.	Calophyllum inophyllum seed oil	-	Not searched (CAS Number missing)
32.	Camellia sinensis leaf extract	84650-60-2	Substance pre-registered.
33.	Camphor benzalkonium methosulfate	52793-97-2	See Appendix 1:
34.	Carotenoids	-	Not searched (CAS Number missing)
35.	Ceria/silica	243133-71-3	Not listed.
36.	Ceria/silica talc	243133-70-2	Not listed.
37.	Cinoxate	104-28-9	Pre-registered substance.
38.	Cobalt dna	-	Not searched (CAS Number missing)
39.	Deschampsia antarctica leaf extract	-	Not searched (CAS Number missing)
40.	Di-methoxycinnamidopropyl ethyldimonium chloride ether	-	Not searched (CAS Number missing)
41.	Di-t-butyl hydroxybenzylidene camphor	123013-10-5	Not listed.
42.	Diacetylcurcumin	19697-86-0	Not listed.
43.	Diethylhexyl 2,6-naphthalate	-	Not searched (CAS Number missing)
44.	Diethylhexyl butamido triazone	154702-15-5	See Appendix 1:
45.	Digalloyl trioleate	17048-39-4 / 27436-80-2	CAS No. 17048-39-4 – Not listed. CAS No. 27436-80-2 – Not listed.
46.	Diisopropyl ethyl cinnamate	-	Not searched (CAS Number missing)
47.	Diisopropyl methyl cinnamate	32580-71-5	Not listed.
48.	Dimethyl paba ethyl cetearyldimonium tosylate	-	Not searched (CAS Number missing)
49.	Dimorpholinopyridazinone	-	Not searched (CAS Number missing)
50.	Diphenyl carbomethoxy acetoxy naphthopyran	169682-22-8	Not listed.
51.	Diphenylmethyl piperazinylbenzimidazole	65215-54-5	Not listed.
52.	Disodium bisethylphenyl triaminotriazine stilbenedisulfonate	24565-13-7	Substance pre-registered.
53.	Disodium distyrylbiphenyl disulfonate	27344-41-8	Joint registration at 100-1,000 t/year Identified uses: Used in cleaning products, paper products and textile finishing (PC 35: Washing and cleaning products (including solvent based products), PC 26: Paper and board dye, finishing and impregnation products: including bleaches and other processing

No.	Substance name	CAS No.	Information in ECHA dissemination database
			aids, PC 34: Textile dyes, finishing and impregnating products; including bleaches and other processing aids).
54.	Disodium phenyl dibenzimidazole tetrasulfonate	180898-37-7	See Appendix 1:
55.	Drometrizole	2440-22-4	See Appendix 2:
56.	Drometrizole trisiloxane	155633-54-8	See Appendix 1:
57.	Ethyl cinnamate	103-36-6	Substance pre-registered.
58.	Ethyl dihydroxypropyl paba	58882-17-0	Substance pre-registered.
59.	Ethyl diisopropylcinnamate	32580-72-6	Substance pre-registered.
60.	Ethyl methoxycinnamate	99880-64-5	Not listed.
61.	Ethyl trimethylbenzoyl phenylphosphinate	-	Not searched (CAS Number missing)
62.	Ethylhexyl bis-isopentylbenzoxazolylphenyl melamine	288254-16-0	Not listed
63.	Ethylhexyl dimethoxybenzylidene dioxoimidazolidine propionate	-	Not searched (CAS Number missing)
64.	Ethylhexyl dimethyl paba	21245-02-3	See Appendix 1:
65.	Ethylhexyl ferulate	-	Not searched (CAS Number missing)
66.	Ethylhexyl methoxycinnamate	5466-77-3	See Appendix 1:
67.	Ethylhexyl methoxycrylene	947753-66-4	Individual registration at 10-100 t/year level. Identified uses: PC 39: Cosmetics, personal care products.
68.	Ethylhexyl methoxydibenzoylmethane	-	Not searched (CAS Number missing)
69.	Ethylhexyl salicylate	118-60-5	See Appendix 1:
70.	Ethylhexyl triazone	88122-99-0	See Appendix 1:
71.	Etocrylene	5232-99-5	Substance pre-registered.
72.	Fluorescent brightener 230	27344-06-5	Joint registration at 100-1,000 t/year level. Identified uses: Used in cleaning products, maintenance products and paints, paper products and textile finishing (PC 9a: Coatings and paints, thinners, paint removes, PC 26: Paper and board dye, finishing and impregnation products: including bleaches and other processing aids, PC 34: Textile dyes, finishing and impregnating products; including bleaches and other processing aids, PC 35: Washing and cleaning products (including solvent based products)).
73.	Fluorescent brightener 367	5089-22-5	Substance pre-registered.
74.	Glyceryl ethylhexanoate dimethoxycinnamate	-	Not searched (CAS Number missing)
75.	Glycol salicylate	87-28-5	Substance pre-registered.
76.	Gossypium herbaceum seedcake extract	223749-08-4	Substance pre-registered.

No.	Substance name	CAS No.	Information in ECHA dissemination database
77.	Hexanediol disalicylate	-	Not searched (CAS Number missing)
78.	Hexyloxy trimethylphenol	148081-72-5	Not listed.
79.	Homosalate	118-56-9	See Appendix 1:
80.	Hydrolyzed euglena gracilis extract	-	Not searched (CAS Number missing)
81.	Hydrolyzed olive fruit	-	Not searched (CAS Number missing)
82.	Hydrolyzed wheat bran	-	Not searched (CAS Number missing)
83.	Hydroxypropyl phenylhydrazinoyl t-butylcarbamate	-	Not searched (CAS Number missing)
84.	Indocyanine green	3599-32-4	Substance pre-registered.
85.	Isoamyl p-methoxycinnamate	71617-10-2	See Appendix 1:
86.	Isobutyl phenylhydrazinoyl methanesulfonamide	-	Not searched (CAS Number missing)
87.	Isopropyl dibenzoylmethane	63250-25-9	Substance pre-registered.
88.	Isopropyl methoxycinnamate	5466-76-2	Substance pre-registered.
89.	Limonia acidissima bark extract	-	Not searched (CAS Number missing)
90.	Limonia acidissima bark powder	-	Not searched (CAS Number missing)
91.	Manganese oxide	11129-60-5	Substance pre-registered.
92.	Menthyl anthranilate	134-09-8	Substance pre-registered.
93.	Menthyl salicylate	89-46-3	Substane pre-registered.
94.	Methoxycinnamidopropyl c18-22 alkyldimonium tosylate	-	Not searched (CAS Number missing)
95.	Methoxycinnamidopropyl hydroxysultaine	-	Not searched (CAS Number missing)
96.	Methoxycinnamidopropyl laurdimonium tosylate	-	Not searched (CAS Number missing)
97.	Methoxycinnamidopropyl polysilsesquioxane	-	Not searched (CAS Number missing)
98.	Methoxycinnamoylpropyl silsesquioxane silicate	-	Not searched (CAS Number missing)
99.	Methyl acrylate/methylene drometrizole methacrylate copolymer	-	Not searched (CAS Number missing)
100.	Momordica cochinchinensis seed aril oil	-	Not searched (CAS Number missing)
101.	Octocrylene	6197-30-4	See Appendix 1:
102.	Octrizole	3147-75-9	See Appendix 2:
103.	Oxobenzoxazinyl naphthalene sulfoanilide	10128-55-9	Substance pre-registered.
104.	Palmitoyl coffee bean extract	-	Not searched (CAS Number missing)
105.	PEG-25 PABA	116242-27-4	See Appendix 1:
106.	Peg/ppg-100/70 tocopheryl ether	-	Not searched (CAS Number missing)
107.	Peg/ppg-2/5 tocopheryl ether	-	Not searched (CAS Number missing)
108.	Peg/ppg-30/10 tocopheryl ether	-	Not searched (CAS Number missing)
109.	Peg/ppg-5/10 tocopheryl ether	-	Not searched (CAS Number missing)
110.	Peg/ppg-5/20 tocopheryl ether	-	Not searched (CAS Number missing)
111.	Peg/ppg-5/30 tocopheryl ether	-	Not searched (CAS Number missing)
112.	Peg/ppg-50/20 tocopheryl ether	-	Not searched (CAS Number missing)
113.	Peg/ppg-70/30 tocopheryl ether	-	Not searched (CAS Number missing)
114.	Phenylbenzimidazole sulfonic acid	27503-81-7	See Appendix 1:
115.	Pinus pinaster bark/bud extract	90082-75-0	Substance pre-registered.
116.	Polyacrylamidomethyl benzylidene camphor	113783-61-2	See Appendix 1:
117.	Polyacrylate-26	-	Not searched (CAS Number missing)
118.	Polyquaternium-59	-	Not searched (CAS Number missing)
119.	Potassium methoxycinnamate	86636-96-6	Not listed.

No.	Substance name	CAS No.	Information in ECHA dissemination database
120.	Potassium phenylbenzimidazole sulfonate	-	Not searched (CAS Number missing)
121.	Quaternium-95	1030827-59-8	Not pre-registered. There is an entry in the Classification and Labelling Inventory.
122.	Red petrolatum	8009-03-8	Joint registration at 100,000-1,000,000 t/year. Many identified uses. Consumer uses given include PC 1: Adhesives, sealants PC 4: Anti-freeze and de-icing products PC 9a: Coatings and paints, thinners, paint removes PC 9b: Fillers, putties, plasters, modelling clay PC 9c: Finger paints PC 12: Fertilisers PC 13: Fuels PC 15: Non-metal-surface treatment products PC 18: Ink and toners PC 23: Leather tanning, dye, finishing, impregnation and care products PC 24: Lubricants, greases, release products PC 27: Plant protection products PC 28: Perfumes, fragrances PC 31: Polishes and wax blends PC 34: Textile dyes, finishing and impregnating products; including bleaches and other processing aids PC 39: Cosmetics, personal care products PC 0: Other: PC 8: Biocidal products (e.g. disinfectants, pest control) Excipient only PC 0: Other: PC 5: Artists supply and hobby preparations / PC 10: Building and construction preparations PC 0: Other: PC 22: Lawn and Garden Preparations, including fertilizers PC 0: Other: PC 6: Automotive Care Products
123.	Rhyolite powder	-	Not searched (CAS Number missing)
124.	Rutinyl succinate	267006-02-0	Not listed.
125.	Sodium acetyl cysteinate	19542-74-6	Substance pre-registered.
126.	Sodium benzotriazolyl butylphenol sulfonate	92484-48-5	Joint registration at the 10-100 t/year level. Registrants: BASF SE, Germany

No.	Substance name	CAS No.	Information in ECHA dissemination database
			Identified consumer uses include use in cleaning agents (PC 35), cosmetics (PC 39) and perfumes (PC 28). Also used as a textile processing aid (industrial use).
127.	Sodium calcium zinc phosphate	-	Not searched (CAS Number missing)
128.	Sodium isoferulate	110993-57-2	Not listed.
129.	Sodium mangoseedate	-	Not searched (CAS Number missing)
130.	Sodium phenylbenzimidazole sulfonate	5997-53-5	Substance pre-registered.
131.	Sodium urocanate	6159-49-5	Not listed.
132.	Sodium/aluminum/iron/sulfate/citrate/hydroxide	-	Not searched (CAS Number missing)
133.	Sodium/aluminum/iron/sulfate/tartarate/hydroxide	-	Not searched (CAS Number missing)
134.	Spirulina platensis powder	223751-80-2	Substance pre-registered.
135.	Sunflower seed oil ethyl ferulate esters	-	Not searched (CAS Number missing)
136.	Synthetic ruby powder	-	Not searched (CAS Number missing)
137.	T-butyl benzoyl peroxide	614-45-9	Joint registration at 1,000-10,000 t/year level. Consumer uses include PC 1: Adhesives, sealants, PC 3: Air care products, PC 8: Biocidal products (e.g. disinfectants, pest control), PC 9a: Coatings and paints, thinners, paint removes, PC 9b: Fillers, putties, plasters, modelling clay, PC 9c: Finger paints, PC 18: Ink and toners, PC 31: Polishes and wax blends, PC 35: Washing and cleaning products (including solvent based products), PC 39: Cosmetics, personal care products.
138.	Tea-phenylbenzimidazole sulfonate	73705-00-7	Not listed.
139.	Tea-salicylate	2174-16-5	Substance pre-registered.
140.	Terephthalylidene dicamphor sulfonic acid	92761-26-7 / 90457-82-2	See Appendix 1:
141.	Tetrahydrocurcumin diacetate	52199-86-7	Not listed.
142.	Titanium dioxide	13463-67-7	See Appendix 1:
143.	Titanium zeolite	-	Not searched (CAS Number missing)
144.	Tocotrienols	6829-55-6	Not listed.
145.	Tripaba panthenol	-	Not searched (CAS Number missing)
146.	Tris(tetramethylhydroxypiperidinol) citrate	220410-74-2	Joint registration at the 0-10 t/year level. Registrants: AllessaProduktion GmbH and BASF Grenzach GmbH, Germany Identified consumer uses include use in cleaning agents (PC 35), and cosmetics/personal care products (PC 39).

No.	Substance name	CAS No.	Information in ECHA dissemination database
147.	Tris-biphenyl triazine	31274-51-8	Joint registration at the 10-100 t/year level. Registrants: BASF SE, Germany Identified consumer uses are in cosmetics/personal care products (PC 39).
148.	Va/crotonates/methacryloxybenzophenone-1 copolymer	-	Not searched (CAS Number missing)
149.	Vitis vinifera seed extract	84929-27-1	Substance pre-registered.
150.	Zinc adenosine triphosphate hydroxide	-	Not searched (CAS Number missing)
151.	Zinc ascorbate hydroxide	-	Not searched (CAS Number missing)
152.	Zinc azelate hydroxide	-	Not searched (CAS Number missing)
153.	Zinc cerium oxide	-	Not searched (CAS Number missing)
154.	Zinc docosahexaenoate hydroxide	-	Not searched (CAS Number missing)
155.	Zinc isomerized linoleate hydroxide	-	Not searched (CAS Number missing)
156.	Zinc linoleate hydroxide	-	Not searched (CAS Number missing)
157.	Zinc linolenate hydroxide	-	Not searched (CAS Number missing)
158.	Zinc oxide	1314-13-2	Joint registration at 100,000-1,000,000 t/year level.
159.	Zinc retinoate hydroxide	-	Not searched (CAS Number missing)

Appendix 4: List of substances identified in the survey

The following list indicates chemical names and registration status of all substances listed in the summary of the survey in Table 20. The entries are organized by CAS numbers.

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
10287-53-3	233-634-3	Benzoic acid, 4-(dimethylamino)-, ethyl ester	Ethyl Dimethyl PABA	Pre-registered			
103597-45-1	403-800-1	2,2'-Methylene-bis-(6-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol)	Methylen bis-benzotriazolyl tetramethylbutyl-phenol	> 100	PC 32: Polymer preparations and compounds	A	
104810-47-1	*600-602-9	Poly(oxy-1,2-ethanediyl), α-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-ω-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropoxy]-	.	Pre-registered			
104810-48-2	*600-603-4	Poly(oxy-1,2-ethanediyl), α-[3-[3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxyphenyl]-1-oxopropyl]-ω-hydroxy-	.	Pre-registered			
11129-18-3	234-374-3	Cerium oxide (nano)	-	Pre-registered			
1137-42-4	214-507-1	4-hydroxybenzophenon	-	Pre-registered			HBB
116242-27-4	.	Ethoxylated ethyl-4-aminobenzoate	Ethoxylated ethyl-4-aminobenzoate	Neither pre-registered nor registered		A	
117-99-7	204-226-2	2-hydroxybenzophenone	-	Pre-registered			
118-56-9	204-260-8	Benzoic acid, 2-hydroxy-, 3,3,5-trimethylcyclohexyl ester	Homosalate	100 – 1000	PC 39: Cosmetics, personal care products	A	HMS
118-58-1	204-262-9	Benzyl salicylate	Benzyl salicylate	1000 - 10,000	PC 31: Polishes and wax blends and PC 35: Washing and cleaning products (including solvent based products), PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances, PC 8: Biocidal products, PC 3: Air care products		

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
118-60-5	204-263-4	2-ethylhexyl salicylate	2-Ethylhexyl salicylate	100 - 1000	PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances.	A	
119-36-8	204-317-7	Methyl salicylate	Methyl salicylate	1000 - 10,000	PC 35: Washing and cleaning products (including solvent based products), PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances, PC 3: Air care products		
119-61-9	204-337-6	Benzophenone	Benzophenone	1000 - 10,000	PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds, PC 28: Perfumes, fragrances. PC 29: Pharmaceuticals. PC 3: Air care products, PC 31: Polishes and wax blends and PC 35: Washing and cleaning products (including solvent based products).		BP
125304-04-3	*603-051-2	Phenol, 2-(2H-benzotriazol-2-yl)-6-dodecyl-4-methyl-, branched and linear	Benzotriazolyl dodecyl p-cresol	Pre-registered			
127519-17-9	407-000-3	95% Benzenepropanoic acid, 3-(2H-benzotriazol-2-yl)-5-(1,1-dimethylethyl)-4-hydroxy-, C7-9-branched and linear alkyl esters (95%)	-	> 1	Is reported to be a new liquid UV absorber designed for coatings. Articles include cars, wood and plastic.		
1314-13-2	215-222-5	Zinc oxide	Zinc oxide	100,000 - 1.000,000	Wide range of product (mixtures) and article categories incl. cosmetics, personal care products (PC39) and Perfumes, fragrances (PC28)		
131-53-3	205-026-8	2,2'-Dihydroxy-4-methoxybenzophenone	Benzophenone-8	Pre-registered			
131-54-4	205-027-3	2,2'-Dihydroxy-4,4'-dimethoxybenzophenone	Benzophenone-6	Pre-registered			
131-55-5	205-028-9	2,2',4,4'-Tetrahydroxybenzophenone	Benzophenone-2	Pre-registered			
131-56-6	205-029-4	2,4-Dihydroxybenzophenone	Benzophenone-1	0 - 10	PC 32: Polymer preparations and compounds, PC 39: Cosmetics, personal care products		BP-1

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
131-57-7	205-031-5	2-Hydroxy-4-methoxybenzophenone	Benzophenone-3	10-100	PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances, PC 9a: Coatings and paints, thinners, paint removers, PC 9b: Fillers, putties, plasters, modelling clay, PC 21: Laboratory chemicals, PC 29: Pharmaceuticals PC 30: Photo-chemicals, PC 32: Polymer preparations and compounds	A	BP-3
13463-67-7	236-675-5	Titanium dioxide	Titanium dioxide, CI 77891	1,000,000–10,000,000	Wide range of product (mixtures) and article categories * 1	A	
134-84-9	205-159-1	Methanone, (4-methylphenyl)phenyl-	Methyl benzophenone	Pre-registered			4-MBP
147315-50-2	*604-583-8	2-(4,6-diphenyl-1,3,5-triazin-2-yl)-5-[(hexyl)oxyl]-phenol	-	> 100	PC 32: Polymer preparations and compounds. Present in plastic articles (AC 13)		
150-13-0	205-753-0	4-Aminobenzoic acid	PABA	Pre-registered. Joint submission: intermediate only			
15087-24-8	239-139-9	1,7,7-trimethyl-3-(phenylmethylene)bicyclo[2.2.1]heptan-2-one	3-Benzylidene camphor	Pre-registered		A	3-BC
153519-44-9	*604-910-4	Hydroxyphenyltriazine	-	1 - 10	PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds. Same registrant indicates the following article categories: AC 1: Vehicles, AC 7 Metal articles AC 8: Paper articles, AC 11: Wood articles and AC 13: Plastic articles. None identified uses in the second registration, only one article category given (AC 0: Other: automotive, wood and plastic).		
154702-15-5	*604-972-2	Bis(2-ethylhexyl) 4,4'-{6-[4-tert-butylcarbamoyl)anilino]-1,3,5-triazine-2,4-diyldiimino}dibenzoate	Diethylhexyl butamido triazone	100 - 1000	PC 39: Cosmetics, personal care products	A	

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
155633-54-8	*919-634-2	Phenol,2-(2H-Benzotriazol-2-yl)-4-Methyl-6-(2-Methyl-3-(1,3,3,3-Tetramethyl-1-(Trimethylsilyl)Oxy)-Disiloxanyl)Propyl	Drometrizole trisiloxane	Pre-registered		A	
1843-05-6	217-421-2	2-Hydroxy-4-octyloxybenzophenone	Benzophenone-12	1000 - 10,000	PC 1: Adhesives, sealants, PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds. PC 2: Adsorbents, PC 3: Air care products, PC 4: Anti-Freeze and de-icing products. Present in rubber and plastic articles (AC 10 and AC 13).		BP-12
187393-00-6	-	2,2'-[6-(4-methoxyphenyl)-1,3,5-triazine-2,4-diyl]bis{5-[(2-ethylhexyl)oxy]phenol}	Bis-ethylhexyloxyphenol methoxyphenyl triazine	10 - 100	PC 21: Laboratory chemicals, PC 39: Cosmetics, personal care products	A	BEMT
207574-74-1	*606-621-9	Polysilicone-15	Polysilicone-15	Pre-registered		A	
21245-02-3	244-289-3	2-Ethylhexyl 4-(dimethylamino)benzoate	Ethylhexyl Dimethyl PABA	Pre-registered		A	OD-PABA
2128-93-0	218-345-2	4-Benzoylbiphenyl	-	Pre-registered			PBZ
220410-74-2	429-370-5	4-Piperidinol, 1-Hydroxy-2,2,6,6-Tetramethyl -, 2-Hydroxy-1,2,3-Propanetricarboxylate (3:1) (salt)	Tris (tetramethylhydroxypiperidinol) citrate	0 - 10	PC 35: Washing and cleaning products (including solvent based products), PC 39: Cosmetics, personal care products		
23328-53-2 / 125304-04-3 / 104487-30-1	401-680-5	A mixture of: isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-(n)-dodecylphenol; isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-(n)-tetracosylphenol; isomers of 2-(2H-benzotriazol-2-yl)-4-methyl-5,6-didodecyl-phenol. n=5 or 6		125304-04-3 is pre-registered, 23328-53-2 and 104487-30-1 is neither registered nor pre-registered			
23949-66-8	245-950-9	N-(2-ethoxyphenyl)-N'-(2-ethylphenyl)oxamide	-	Registered, tonnage data confidential	PC 1: Adhesives, sealants, PC 9a: Coatings and paints, thinners, paint removers, PC 9b: Fillers, putties, plasters, modelling clay, PC 32: Polymer preparations and compounds.		

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
2440-22-4	219-470-5	2-(2H-benzotriazol-2-yl)-p-cresol	Drometrizole	1000 - 10,000	PC 9a: Coatings and paints, thinners, paint removers, PC 9b: Fillers, putties, plasters, modelling clay, PC 32: Polymer preparations and compounds, PC 1: Adhesives, sealants. Present in rubber and plastic articles (AC 10 and AC 13).		
24650-42-8	246-386-6	2,2-dimethoxy-1,2-diphenylethan-1-one	Phenyldimethoxyacetophenone	100 - 1000	Not registered in any categories of consumer or professional use.		
24650-42-8	246-386-6	2,2-Dimethoxy-2-phenylacetophenone	Phenyldimethoxyacetophenone	Same as above	Same as above		
25322-68-3	500-038-2	Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy-	PEG	100 - 1000	PC 32: Polymer preparations and compounds, PC 35: Washing and cleaning products (including solvent based products), PC 29: Pharmaceuticals, PC 39: Cosmetics, personal care products		
25973-55-1	-	2-(2H-benzotriazol-2-yl)-4,6-ditertpentylphenol	2-(2'-Hydroxy-3',5'-di-t-amylphenyl) benzotriazol	100 - 1000	PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds. Present in plastic articles (AC13).		UV-328
27503-81-7	248-502-0	2-Phenyl-1H-benzimidazole-5-sulphonic acid	Phenylbenzimidazole sulfonic acid	100 - 1000	PC 39: Cosmetics, personal care products.	A	
2943-75-1	220-941-2	Triethoxycaprylylsilane	Triethoxycaprylylsilane	1000 - 10,000	PC 9a: Coatings and paints, thinners, paint removers, PC 39: Cosmetics, personal care products, PC 32: Polymer preparations and compounds, PC 1: Adhesives, sealants, PC 15: Non-metal-surface treatment products, PC 21: Laboratory chemicals		
302776-68-7	443-860-6	Benzoic Acid, 2-[4-(Diethylamino)-2-Hydroxybenzoyl]-, Hexyl Ester	Diethylamino hydroxybenzyol hexyl benzoate	100 - 1000	PC 39: Cosmetics, personal care products	A	

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
3069-40-7	221-338-7	Trimethoxyoctylsilane	Trimethoxycaprylylsilane	100 - 1000	PC 1: Adhesives, sealants, PC 15: Non-metal-surface treatment products, PC 21: Laboratory chemicals		
3147-75-9	221-573-5	2-(2H-bBenzotriazol-2-yl)-4-(2,4,4-trimethyl-2-pentanyl)phenol	-	100 - 1000	PC 32: Polymer preparations and compounds . Present in rubber and plastic articles (AC 10 and AC 13).		UV-329
3147-75-9	221-573-5	2-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol	Octrizole	100 - 1000	PC 32: Polymer preparations and compounds. Present in rubber and plastic articles (AC 10 and AC 13).		
31570-04-4	250-709-6	2,4-bis(1,1-dimethylethyl)phenol, phosphite (3:1)	-	10,000 – 100,000	PC 32: Polymer preparations and compounds, PC 1: Adhesives, sealants. Present in plastic articles (AC 13).		
346608-13-7/90622-58-5	-/292-460-6	Dispersion af ceriumoxid	-	90622-58-5 is pre-registered			
36861-47-9	253-242-6	(.+-.)-1,7,7-trimethyl-3-[(4-methylphenyl)methylene]bicyclo[2.2.1]heptan-2-one	4-Methylbenzylidene camphor	Pre-registered		A	4-MBC
3846-71-7	223-346-6	2-Benzotriazol-2-yl-4,6-di-tert-butylphenol	-	Pre-registered			UV-320
3864-99-1	223-383-8	2-(5-chloro-2H-benzotriazol-2-yl)-4,6-bis(2-methyl-2-propanyl)phenol	-	Pre-registered			UV-327
3864-99-1	223-383-8	2-(2'-Hydroxy-3',5'-di-t-butylphenyl)-5-chlorobenzotriazol	-	Pre-registered			
3896-11-5	223-445-4	Phenol, 2-(5-chloro-2H-benzotriazol-2-yl)-6-(1,1-dimethylethyl)-4-methyl-	Bumetrizole	100 - 1000	PC 1: Adhesives, sealants, PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds. Present in rubber and plastic articles (AC 10 and AC 13).		
4046-02-0	223-745-5	Ethyl 3-(4-Hydroxy-3-Methoxyphenyl)-2-Propenoate	Ethyl Ferulate	Pre-registered			

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
4065-45-6	223-772-2	5-Benzoyl-4-hydroxy-2-methoxybenzenesulfonic acid	Benzophenone-4	1000 - 10,000	PC 39: Cosmetics, personal care products, PC 31: Polishes and wax blends and PC 35: Washing and cleaning products (including solvent based products), PC 29: Pharmaceuticals	A	BP-4
41556-26-7	255-437-1	Bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacat	-	Pre-registered			
5089-22-5	225-803-5	2,2'-(Naphthalene-1,4-diyl)bis(benzoxazole)	Fluoroscent brightener 367	Pre-registered			
52188-76-8	-	2-Benzotriazol-2-yl-4-(2,4,4-trimethylpentan-2-yl)phenol	-	Neither pre-registered nor registered			
5232-99-5	226-029-0	2-Propenoic acid, 2-cyano-3,3-diphenyl-, ethyl ester	Etocrylene	Pre-registered			
5466-77-3	226-775-7	2-ethylhexyl 4-methoxy cinnamate	Ethylhexyl methoxycinnamate	1000 – 10,000	PC 21: Laboratory chemicals, PC 28: Perfumes, fragrances, PC 29: Pharmaceuticals, PC 30: Photo-chemicals, PC 39: Cosmetics, personal care products.	A	OMC / OMC
5495-84-1	226-827-9	2-Isopropylthioxanthon	-	Pre-registered			ITX
577-11-7	209-406-4	Docusate sodium	Diethylhexyl sodium sulfosuccinate	10,000 +	Wide range of product (mixtures) and article categories		
611-99-4	210-288-1	4,4'-Dihydroxybenzophenone		Pre-registered			
6197-30-4	228-250-8	2-Propenoic acid, 2-cyano-3,3-diphenyl-, 2-ethylhexyl ester	Octocrylene	1000 – 10,000	PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances, PC 9a: Coatings and paints, thinners, paint removers, PC 9b: Fillers, putties, plasters, modelling clay, PC 21: Laboratory chemicals, PC 29: Pharmaceuticals PC 30: Photo-chemicals, PC 32: Polymer preparations and compounds	A	OC
6337-43-5	228-726-5	Tetraethyl 2,2'-(1,4-phenylendimethylidyn) bismalonat	-	Pre-registered			
63843-89-0	264-513-3	Bis(1,2,2,6,6-pentamethyl-4-piperidyl) [[3,5-bis(1,1-dimethylethyl)-4-hydroxyphenyl]methyl]butylmalonate	-	100 - 1000	PC 1: Adhesives, sealants, PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds		

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
65447-77-0	*613-797-0	Butanedioic acid, 1,4-dimethyl ester, polymer with 4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol	-	Pre-registered			
70321-86-7	274-570-6	2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol	-	100 - 1000	PC 32: Polymer preparations and compounds. PC 9a: Coatings and paints, thinners, paint removers. Present in plastic articles (AC 13).		UV-234
70321-86-7	-	phenol, 2-(2H-benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)-phenol	-	100 - 1000	PC 9a: Coatings and paints, thinners, paint removers, PC 32: Polymer preparations and compounds. Present in rubber and plastic articles (AC 10 and AC 13).		
70356-09-1	274-581-6	1-[4-(1,1-Dimethylethyl)phenyl]-3-(4-methoxyphenyl)propane-1,3-dione	Butyl methoxydibenzoylmethan	1000 - 10,000	PC 39: Cosmetics, personal care products, PC 28: Perfumes, fragrances.	A	BM-DBM
71617-10-2	275-702-5	Isopentyl p-methoxycinnamate	Isoamyl P-methoxycinnamate	100 - 1000	PC 39: Cosmetics, personal care products.	A	
7443-25-6	231-185-8	Dimethyl 2-[(4-methoxyphenyl)methyliden]propanedionat	-	Pre-registered			
82919-37-7	280-060-4	Methyl-1,2,2,6,6-pentamethyl-4-piperidylsebacat	-	Pre-registered			
83846-85-9	281-064-9	4-(4-Methylphenylthio)benzophenone	-	Pre-registered			
84650-60-2	283-519-7	-	Camellia sinensis leaf extract	Pre-registered			
84929-27-1	284-511-6	Vitis vinifera seed extract	-	Pre-registered			
88122-99-0	402-070-1	Benzoic acid, 4,4',4''-(1,3,5-triazine-2,4,6-triyltriimino)tris-,tris(2-ethylhexyl) ester; octyl triazone	Ethylhexyl triazone	10 – 100; 100 - 1000	PC 39: Cosmetics, personal care products.	A	
92761-26-7 / 90457-82-2	410-960-6	3,3'-(1,4-Phenylenedimethylene)bis[7,7-dimethyl-2-oxo-bicyclo[2.2.1]heptane-1-methanesulfonic acid]	Terephthalylidene dicamphor sulfonic acid	Pre-registered		A	
ikke angivet	ikke angivet	Ethylene/methacrylate copolymer		Not searched (CAS No. missing)			

CAS No.	EC No.	IUPAC name	INCI name	REACH registration status	Registered product categories	Approved filter (A)	Abbreviation
ikke angivet	ikke angivet	3-glycidyloxypropyltrimethoxy silane type	-	Not searched (CAS No. missing)			
ikke angivet	ikke angivet	4-Aminophenyl-1H-benzimidazol-5-sulfonic acid		Not searched (CAS No. missing)			
ikke angivet	ikke angivet	alpha-3-[3-(2H-banzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1-omega-hydroxy-poly(oxyethylene) and alpha-3-[3-(2H-benzotriazol-2-yl)-5-t-butyl-4-hydroxyphenyl]propionyl-1- omega-3-(3-(2H-benzotriazol-2-yl)-5-t-butyl-4- hydroxyphe-phenyl)propionyloxypoly(oxyethyl)	-	Not searched (CAS No. missing)			
ikke angivet	ikke angivet	Pentamethyl piperidyl sebacate type	-	Not searched (CAS No. missing)			

Survey and health assessment of UV filters

UV-protective substances are used to prevent the harmful effects of UV radiation to human skin and to different materials. The substances are added to chemical products and materials that may result in consumer exposure. Studies have demonstrated the presence of UV-filters in the environment, in biota, in breast milk and urine of children, even during winter, where children are not expected to be exposed to sunscreens. The overall aim of the project was therefore to map the occurrence of UV filters and UV absorbers in cosmetics and other products that may lead to consumer exposure, and to assess the extent to which the application could give rise to exposure of consumers and unwanted effects on the environment and human health.

Based on the survey, it is not possible to draw a complete picture of actual consumer exposure to UV filters and UV-absorbers in different product types, but results from human biomonitoring studies and investigations of aquatic environments and biota demonstrate that exposure takes place, and that cosmetics are a contributing factor.

When some of the risk calculations indicate that the approved UV filters present a hazard under certain conditions, although these are considered safe to use by SCCS in the maximum allowed concentrations, it may be due to fact that the assessments made in the present study, have the character of a screening based on a less complete data set.

The risk associated with exposure to sources other than cosmetics are not quantified due to lack of data. However, it is estimated that this exposure will only contribute a fraction of the exposure estimated for cosmetics. Shortcomings in the project are due lack of detailed knowledge of the different sources of exposure, the extent of the exposure from sources other than cosmetics, and the likelihood of exposure constituting a problem.

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