UV-328

RISK MANAGEMENT EVALUATION

Prepared by the intersessional working group of the
Persistent Organic Pollutants Review Committee

2nd draft, May 2022

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Executive Summary

1. In 2020, Switzerland submitted a proposal to list UV-328 in Annex A to the Convention. In January 2022, at its 17th meeting, the POPRC decided that UV-328 is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted. An intersessional working group was established to prepare a risk management evaluation for UV-328 that includes an analysis of possible control measures in accordance with Annex F to the Convention for consideration by the POPRC at its 18th meeting in September 2022.

2. UV-328 is a phenolic benzotriazole that is substituted with two *tert*-pentyl groups at the 4th and 6th position of its phenolic moiety. UV-328 was listed as a substance of possible concern in 2006 under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) and it is subject to national control actions in several countries.

3. UV-328 has been produced with a global production volume above 1,000 tonnes per annum (t/a). Data indicates that most of the countries import the substance instead of producing it domestically. UV-328 is used as a UV absorber as it can absorb the whole spectrum of UV light without being destroyed. Based on the available information, the main uses are in the automotive industry, such as, automotive paints, coatings, sealants, adhesives, plastics and rubbers to protect materials from UV light-induced degradation or color-change, as well as various automotive fluids, such as, cooling and hydraulic liquids, and lubricants in motor oil. It can also be used as additives and printing inks in the plastics and rubbers for outdoor furniture, construction materials and food packaging (in non-food contact layer) and wood products. Other uses also include applications in leather and textiles as well as cosmetics. Typical use concentrations range from 0.1 to 3% by weight.

4. Releases of UV-328 occur during all life cycle stages due to past and present production, manufacturing, transportation and final use of the substance as well as during the use, disposal and end of life treatment of products containing UV-328. As UV-328 is not chemically bound to materials, the substance may be released from products and enter the environment, indicating the importance of the use and waste phase. Particular attention should be given to plastic litter containing UV-328 which might represent the main source of UV-328 in the marine environment and for biota ingesting plastics. Other sources of release include machine wash liquids, detergents, cosmetics, fragrances and air fresheners as well as textiles. Sewage sludge applied as a fertilizer is another source of release of UV-328 to the environment.

5. The most efficient control measure would be to list UV-328 in Annex A of the Convention, banning the production, use, import and export with no exemptions. Since releases occur during the whole life cycle, environmentally sound management of stockpiles and wastes containing UV-328 are also essential.

6. Alternatives for the substitution of UV-328 are widely available, i.e., other phenolic benzotriazoles, benzophenones, hindered amine light stabilizers (HALS), oxalanilides and cyanoacrylates. Safer alternatives for the most relevant applications of UV-328 seem to be technically feasible and accessible. Information on specific uses, where chemical or non-chemical alternatives are not available, could not be identified. This is supported by industry feedback which suggests that the alternative substances represent viable alternatives to UV-328. Since no applications for authorization have so far been submitted in the EU, the placing of UV-328 on the market is expected to discontinue in the EU before 2024. Depending on the specific requirements of the final plastic application, alternative chemistries indicated above are available to stabilize plastics. However, each UV absorber has its specific substance properties. Therefore, the selection of a replacement candidate must be evaluated in order to avoid reduction of the specified product performance. Alternatives to UV-328 should be selected carefully in order to avoid regrettable substitution. Safer alternatives should be pursued.

7. The European Automotive Manufacturer's Association (ACEA) is currently in the process of phasing out UV-328. By 2026 the substance will be phased out from their new products. Therefore, ACEA concludes that a ban of UV-328 should not be effective prior to January 2026. However, also beyond this date, there would be challenges for legacy spare parts (LSPs) containing UV-328. According to ACEA, the substitution of UV-328 in LSPs will not be feasible, in particular for vehicles which are no longer in mass production or where the manufacturing of spare parts has ceased, and spare parts have been put on stock. A time limited exemption for LSPs could avoid unwanted impacts on manufacturers of spare parts and on the reparability of vehicles.

8. UV-328 containing waste should be managed in an environmentally sound manner in accordance with Article 6.1.(d) of the Convention. To enable destruction or irreversible transformation of the UV-328 content of waste and to avoid recovery, recycling, reclamation, direct reuse or alternative uses, the materials containing UV-328 should therefore be separated from waste streams. Reuse and recycling of UV-328 containing wastes and stockpiles is not allowed under the Convention. However, when products are entering the waste stream it is not always clear whether they contain UV-328 and they may be difficult to separate. For separation, it may be important to know which products and/or components contain UV-328. This information should be provided by the producers.

9. The destruction of UV-328 containing waste in accordance with Article 6 of the Convention is seen as the most efficient way of ensuring no further spread and emission of the substance. As UV-328 decomposes at temperatures below 200 °C, it can be assumed that it is completely destroyed in appropriate waste incineration facilities. Technologies for the destruction and irreversible transformation of UV-328 in wastes will be evaluated jointly with the Basel Convention.

10. UV-328 has been detected in various environmental media, including ambient air, water, soil, sediment, biota and humans. It is considered to be persistent and bioaccumulative, with significant adverse human health and/or environmental effects. Due to its long-range environmental transport, it has been detected in many regions across the world. A positive impact on human health and the environment can be expected from a global elimination of UV-328.

11. The Committee recommends, in accordance with paragraph 9 of Article 8 of the Convention, the Conference of the Parties to the Stockholm Convention to consider listing and specifying the related control measures of UV-328 in Annex A with a specific time-limited exemption for the use in LSPs for motor vehicles and industrial machines.

1 Introduction

12. In May 2020, Switzerland submitted a proposal to list UV-328 in Annex A to the Convention. The proposal was submitted in accordance with Article 8 of the Convention, and was reviewed by the Persistent Organic Pollutants Review Committee (POPRC) at its sixteenth meeting held in January 2021 where the Committee concluded that UV-328 fulfilled the screening criteria in Annex D and that a draft risk profile for UV-328 shall be prepared in accordance with Annex E to the Convention (see decision POPRC-16/3).

13. At its seventeenth meeting in January 2022, the POPRC adopted the risk profile and decided that UV-328 is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted. The Committee also decided to establish an intersessional working group to prepare a risk management evaluation that includes an analysis of possible control measures for UV-328 in accordance with Annex F to the Convention. The Committee invited Parties and observers to submit to the Secretariat the information specified in Annex F on UV-328 before 14 March 2022.

1.1 Chemical identity of UV-328

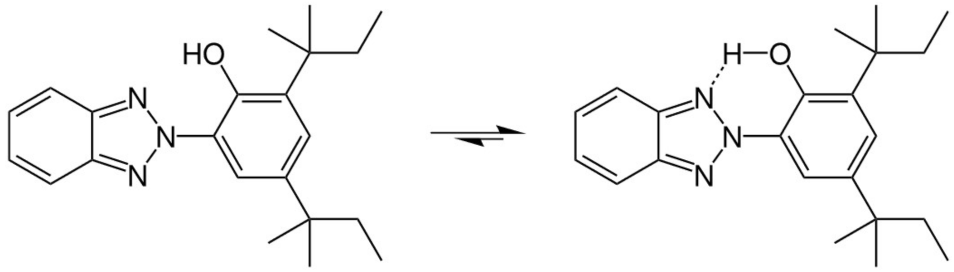
14. UV-328 is a phenolic benzotriazole that is substituted with two *tert*-pentyl groups at the 4th and 6th position of its phenolic moiety. UV-328 absorbs the full spectrum of UV light in a fully reversible and non-destructive process (ECHA, 2014). It is therefore used as a UV absorber to protect various surfaces against discoloration and weathering under UV/sunlight. Table 1 shows the various chemical identifiers and registration numbers of UV-328. Table 2 shows the molecular characteristics of UV-328, which can exist in both open and closed forms.

Table 1. Names and registration numbers of UV-328.

Common name	UV-328
IUPAC name	2-(2*H*-Benzotriazol-2-yl)-4,6-bis(2-methylbutan-2-yl)phenol
CAS name	Phenol, 2-(2*H*-benzotriazol-2-yl)-4,6-*bis*(1,1-dimethylpropyl)-
Synonym	2-(2*H*-Benzotriazol-2-yl)-4,6-di-*tert*-pentylphenol (BDTP), 2-(2′-Hydroxy-3′,5′-di-*t*-amylphenyl) benzotriazole
Commercial names	BLS 1328, Chiguard 328, Chisorb 328, Cyasorb UV 2337, Eversorb 74, GSTAB 328, Hostavin 3310 P, Kemisorb 74, Lowilite 28, Milestab 328, Seesorb 704, Songsorb 3280, Sumisorb 350, Thasorb UV328, Tin 328, Tinuvin 328, UV 2337, UV 74, Uvinul 3028, Viosorb 591
CAS number	25973-55-1
EC number	247-384-8

Table 2. Molecular characteristics of UV-328.

Molecular formula	$C_{22}H_{29}N_3O$
Molecular weight	351.5 g/mol
Substance type	Mono-constituent
Degree of purity	≥ 80–100% (w/w)

Structural formulas (left: open form; right: closed form)	

1.2 Conclusions of the POPs Review Committee regarding Annex E information

15. Based on the draft risk profile, at its seventeenth meeting in January 2022, the POPRC adopted the risk profile (UNEP/POPS/POPRC.17/13/Add.3) and:

(a) Decided, in accordance with paragraph 7 (a) of Article 8 of the Convention, that UV-328 is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted;

(b) Also decided, in accordance with paragraph 7 (a) of Article 8 of the Convention and paragraph 29 of the annex to decision SC-1/7 of the Conference of the Parties, to establish an intersessional working group to prepare a risk management evaluation that includes an analysis of possible control measures for UV-328 in accordance with Annex F to the Convention;

(c) Invited in accordance with paragraph 7 (a) of Article 8 of the Convention, Parties and observers to submit to the Secretariat, before 14 March 2022, the information specified in Annex F.

1.3 Data sources

1.3.1 Overview of data submitted by Parties and observers

16. This risk management evaluation is primarily based on information that has been provided by Parties to the Convention and observers. [1] Information specified in Annex F forms was submitted by the following Parties and observers:

(d) Parties: Belarus, Canada, European Union (EU), Germany, Japan, Monaco, Netherlands, Norway, Republic of Korea, United Kingdom of Great Britain and Northern Ireland (UK)

(e) European Automobile Manufacturers' Association (ACEA), International Pollutants Elimination Network (IPEN) and Alaska Community Action on Toxics (ACAT)

1.3.2 Other key data sources

17. In addition to the above-mentioned references received from Parties and observers, information has been used from open information sources as well as scientific literature (see list of references). The following key references were used as a basis to develop the present document:

(a) The risk profile for UV-328 (UNEP/POPS/POPRC.17/13/Add.3);

(b) Support document for the identification of UV-328 as a Substance of Very High Concern in the European Union (ECHA, 2014);

(c) Estimation of the number and types of applications for UV-328 after being added to the Authorisation list in February 2020 (ECHA, 2020).

(d) Assessment of UV-328 by Environment and Climate Change Canada and Health Canada (ECCC and Health Canada, 2016), as well as other national evaluations on UV-328;

(e) Registration dossier submitted for the authorization of UV-328 under the European Union's Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation (ECHA, 2022b);

[1] Submissions are available at http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC17/POPRC17Followup/AnnexFUV328Submission/tabid/9100/Default.aspx

1.4 Status of the chemical under international conventions and frameworks

18. Under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), UV-328 was listed as a substance of possible concern in 2006 (as cited by Germany, 2014).

1.5 Any national or regional control actions

19. According to the risk profile (UNEP/POPS/POPRC.17/13/Add.3) and Annex F submissions, national and/or regional regulations related to UV-328 comprise the following:

20. UV-328 has been identified as a Substance of Very High Concern (SVHC) in the EU due to its persistent, bioaccumulative and toxic (PBT) and very persistent and very bioaccumulative (vPvB) properties under Regulation (EC) No 1907/2006 (REACH Regulation), and was included to the Candidate List for Authorisation on 17 December 2014. UV-328 was included in the Authorisation List (Annex XIV to REACH) on 24 June 2020 with a sunset date of 27 November 2023 and latest application date of 27 May 2022. At the time of submitting the Annex F information (March 2022), no applications for authorization have been received. Only certain uses are exempted from the authorization requirement under REACH, e.g., uses as isolated intermediates or for scientific research and development activities (Annex F EU, 2022). Companies supplying articles containing UV-328 in a concentration above 0.1% weight by weight (w/w) on the EU market have to submit information on these articles to the SCIP database, as from 5 January 2021. SCIP is the database for information on Substances of Concern In articles as such or in complex objects (Products) established under the Waste Framework Directive (WFD) (Annex F EU, 2022).

21. The placing on the market and the professional or commercial use of UV-328 and preparations containing UV-328 are prohibited in Switzerland from 2 August 2024. Only uses, for which either an authorization is granted in the EU or an exemption is granted by the Swiss federal authorities, are exempt from these prohibitions (Swiss Federal Council, 2022).

22. In Norway, UV-328 was added to the national list of priority substances in 2017 (Annex E, 2021).

23. In the UK, there were no specific control actions for UV-328. However, screening work for UV-328 was conducted by the Environment Agency (EA) in England in 2020. Following the EA's Prioritization and Early Warning System (PEWS) screening in June 2021, UV-328 was added to the EA's Gas Chromatography Mass Spectrometry (GCMS) target screen for water samples (Annex F UK, 2022).

24. As UV-328 is restricted in the legislation of the Kingdom of Bahrain, there is no import and use of UV-328 in the country (Bahrain, 2021).

25. In Australia, the industrial use of UV-328 is not subject to any specific national environmental regulation (NICNAS, 2017).

26. According to Canada's assessment of UV-328, it has been concluded that UV-328 does not meet the criteria under section 64 of the Canadian Environmental Protection Act, as it is not entering the Canadian environment in a quantity or concentration having a harmful effect on the environment or constituting a danger to human life or health (ECCC and Health Canada, 2016). There may, however, be concerns if import and use quantities were to increase in Canada. Such increases could result in additional releases and environmental exposure, resulting in environmental risk. Therefore, the substance was added to the Canadian Domestic Substances List (DSL) Inventory Update to monitor changes in Canadian import, use and release (Annex F Canada, 2022).

2 Summary information relevant to the risk management evaluation

Production, consumption and trade

27. The following paragraphs on production, use, occurrence in low concentrations and releases of UV-328 are largely based on the Risk Profile (UNEP/POPS/POPRC.17/13/Add.3).

28. The earliest known production of UV-328 began in 1970 (Lopez-Avila & Hites, 1980). No time trends are publicly available regarding the global production of UV-328 since production began. According to the OECD Existing Chemicals Database, UV-328 is designated as a high production volume chemical (HPVC), with production > 1,000 t/a (OECD, 2021). On a global scale, UV-328 is used in large quantities today (NICNAS, 2017). Worldwide, there are 77 suppliers of UV-328 (ECHA, 2020).

29. In the EU, UV-328 is registered under the total tonnage band of 100–1,000 t/a (ECHA, 2022b). One registrant and one co-registrant of UV-328 stated that 100 % of the substance is imported into the EU and placed on the market as a pure substance or in mixtures (ECHA, 2020). Thereof, the majority is imported from Asia (ECHA, 2020). The substance is manufactured and/or imported by 11 registrants with companies being located in Belgium, Germany, the Netherlands and Italy (Annex F EU, 2022). Feedback from manufacturers suggests a complex supply chain. Accordingly, manufacturers mainly provide masterbatches containing UV-328 to converters for further processing.

The converters supply plastics to producers who deliver final plastic products to the end users (ECHA, 2020). There are 9 European suppliers of UV-328 (ECHA, 2020).

30. The amount of UV-328 produced in the Netherlands is unknown. Locations where UV-328 is manufactured include Capelle a/d IIssel, Mijdrecht and Uithoorn (Annex F The Netherlands, 2022). In Hungary, 21 companies use UV-328 at < 1 t/a/company (Annex E, 2021).

31. In Monaco, UV-328 is not produced nor used (Annex F Monaco, 2022).

32. According to the Annex F submission of Norway (2022), UV-328 is not produced in Norway. The imported sum of UV-327, UV-328, UV-320 and UV-350 registered in the Norwegian Products Register declined from 1.9 t in 2009 to 0.17 t in 2019.

33. In the UK, there is one registrant of UV-328, which comes under the tonnage band of 100–1,000 t/a. As this registrant held an EU REACH registration, it is assumed that the registrant is an importer rather than a UK based producer of UV-328 (Annex F UK, 2022).

34. According to ECCC and Health Canada (2016), UV-328 is not manufactured in Canada. In 2000, total import of UV-328 was in the range of 100 to 1,000 t. In the years 2012 and 2013, total Canadian import of UV-328 were significantly lower (i.e. in the range of 10 to 100 t per year, excluding quantities in finished articles, for which no information is available).

35. In the US, the annual production volume ranged between 450 to 4,500 t from 1986 to 2006 (US EPA, 2011, as cited in ECCC and Health Canada, 2016). Between 2011 and 2015 the reported national aggregate production volume was in the same range (450–4,500 t/a) (US EPA, 2018). The production volume includes domestically manufactured and imported volumes of UV-328. Of 11 companies and company sites for which data on the production volume is available, only one company/company site reported that UV-328 is manufactured domestically. The remaining companies/company sites reported that the substance was imported (8 companies/company sites) or claimed the data as Confidential Business Information (CBI) (2 companies/company sites) (US EPA, 2018). Based on the available data, the total volume of UV-328 imported into the US was 415, 580, 573 and 485 t/a in 2012, 2013, 2014 and 2015 respectively (US EPA, 2018)[2]. Only one company reported on relatively small volumes of UV-328 being exported in 2015 (ca. 1.0 t/a) (US EPA, 2018).

36. In Mexico, total imports of UV-328 in 2015 and 2017 were 90 t and 51 t, while total exports were 2 t and 0.9 t, respectively (Annex E, 2021).

37. In Russia, UV-328 is imported from the People's Republic of China. However, no tonnage or company information has been reported (Annex E, 2021). In Belarus, UV-328 has never been produced (Annex F Republic of Belarus, 2022).

38. In Japan, the annual production and usage volume of UV-328 is currently below 1,000 t (Annex F Japan, 2022).

39. In 2018, 58 t of UV-328 were imported into the Republic of Korea. Based on information gathered from the 'Statistical Survey for Chemicals' under the Chemical Control Act, 0.25 t of UV-328 were produced in the Republic of Korea in 2018 (Annex F Republic of Korea, 2022).

40. Data on consumption volumes is available at the national level in the SPIN database[3] for Denmark, Sweden, Finland and Norway. The total volume of UV-328 consumed in these countries decreased from 30 t in 2000 to 5 t in 2010. In 2019, the total consumption volume was 5.5 t compared to 3.7 t, 4.3 t and 2.8 t in 2018, 2017 and 2016 respectively. This indicates a decreasing trend since 2000 but an increasing trend from 2016 to 2019 (SPIN, 2022). The total consumption volume of UV-328 in all four countries from 2000 to 2019 amounts to 491.5 t. At country level, the analysis of the consumption volumes indicates a declining consumption of UV-328 in Denmark (from 3 t in 2000 to 0.1 t in 2019), Sweden (from 6 t in 2000 to 0.7 t in 2019) and Norway (from 21 t in 2000 to 0.2 t in 2019) (SPIN, 2022). It should be noted that in Sweden a sharp increase of UV-328 consumption to 244 t in 2015 was recorded (SPIN, 2022). In Finland, UV-328 consumption decreased from 8 t in 2001 to 0 t in the years 2010–2013. Since then, data suggest an increasing consumption of UV-328 in Finland to up to 4.5 t in 2019 (SPIN, 2022).

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[2] In 2012, 2013 and 2014, data on imports was available from 6 companies/company sites while for 2015 data was only available for 5 companies/company sites. For other companies/company sites, the data was claimed as CBI (US EPA, 2018).

[3] Database on the use of Substances in Products in the Nordic Countries (SPIN).

41. According to Grob et al. (2016)[4], the total global consumption of light stabilizers in thermoplastics was 24,800 t in 2009. Thereof, hindered amine light stabilizers (HALS) accounted for 46 % (11,500 t) of the total consumption followed by benzotriazoles with 27 % (6,700 t) and benzophenones with 20 % (4,900 t) as well as other light stabilizers with 7 % (1,700 t). Hence, in 2009, benzotriazoles including UV-328 accounted for about one quarter of the total consumption of light stabilizers in thermoplastics.

42. In summary, UV-328 is produced in significant quantities worldwide with a global production volume > 1,000 t/a. No time trends are publicly available as regards the global production. Data on specific production volumes at the national level is only available to a limited extent. Data indicates that most of the countries for which data is available mainly import UV-328 instead of producing it domestically.

Use

43. UV-328 is used in a variety of applications and products. It is applied as a UV stabilizer in plastic shrink films, outdoor furniture and clear coat automotive finishes, as well as for light stabilization in coatings, acrylonitrile butadiene styrene (ABS) resin, epoxy resin, fiber resin, polypropylene (PP), rigid and flexible polyvinyl chloride (PVC) and polystyrene (PS) (Bolgar et al., 2016; ECHA, 2020). It is also used in unsaturated polyesters, polyacrylate and polycarbonate (PC) (ECHA, 2020). Additionally, it is used in construction materials, fillers, surface treatments, adhesives, paints/lacquers/varnishes, thinners, paint removers, printing inks, consumer fragrances, cosmetics, fabric/textile/leather products and as inert ingredient in pesticides (ECHA, 2018, 2020; Mikkelsen et al., 2015). UV-328 was found in toys and hair accessories (Karlsson et al., 2022) and is used as a UV absorber in polyolefins, polyurethanes, PVC, polyacrylate, epoxy and elastomers (ECHA, 2020).

44. According to information provided in the United States Environmental Protection Agency (US EPA) ChemView database, UV-328 is mainly used for industrial purposes in the US. Eight out of nine companies/company sites for which data is available indicate that UV-328 is used for industrial purposes, while commercial use (three companies/company sites) and consumer use (one company/company site) is less relevant (US EPA, 2018).[5] Industrial use of UV-328 includes its use as UV absorber, light stabilizer, antioxidant, paint additive and coating additive, photosensitive chemical or adsorbent and absorbent (US EPA, 2018). Commercial and consumer use includes the use in paints and coatings as well as adhesives and sealants (US EPA, 2018).

45. Based on the SPIN database, the product or use categories of UV-328 in 2019 included adhesives and binding agents (3.3 t/a in Finland and 0.1 t/a in Denmark), paints lacquers and varnishes (0.2 t/a in Finland and 0.1 t/a in Norway) and construction materials (0.1 t/a in Norway) (SPIN, 2022). Thus, in these Nordic countries, UV-328 was mainly used for adhesives and binding agents in 2019.

46. In Australia, UV-328 is used in industrial sealants in aftermarket automotive products (NICNAS, 2017). In Canada, 63% of UV-328 was used in the plastics sector and 37% in paints and coatings in 1986; and currently UV-328 is used in automotive paints and coatings, to a minor degree as a sealant in the manufacture of automobiles, and as an additive in plastic food packaging in the non-food contact layer (ECCC and Health Canada, 2016). In Norway, UV-328 is mainly used in paints and varnishes, but also in rubber and transparent plastics (Annex E, 2021). In Sweden, UV-328 is mainly used as an additive in plastics, paints and sealants (Annex E, 2021). In Russia, UV-328 is mainly used as a corrosion inhibitor (anti-corrosion agent), in polishes for metal surfaces, as well as for the gravimetric determination of metals such as copper, silver and zinc (Annex E, 2021).

47. According to a global chemicals manufacturer, approximately 50% of their UV-328 containing products are used as UV-protection agents in coatings, especially for cars and special industrial wood coatings. Ca. 40% are used as UV protection agents for plastics, rubber, and polyurethanes. It is for example used in roof lights and PVC membranes. The rest is used in cosmetics (e.g., as sun protection agents) (Germany, 2014).

48. In various jurisdictions, UV-328 is used as an additive in the non-food-contact layer of food contact articles. According to the FACET (Flavors, Additives, and food Contact materials Exposure Task) tool of the European Commission's Joint Research Centre (JRC), UV-328 is included as being used in food contact materials (JRC, 2017). UV-328 is also part of the 2013 inventory list of the European Printing Ink Association (EuPIA) for additives in printing ink used on the non-food contact surface of food contact articles (EuPIA, 2013). In Switzerland, UV-328 is included in the "List of permitted substances for the production of packaging inks, and related requirements" of the Ordinance on Materials and Articles in Contact with Food (Swiss FDHA, 2020). In the USA, UV-328 is listed in the US Food and Drug Administration's (FDA) Inventory of Indirect Additives used in Food Contact Substances (US

[4] Note: Grob et al. (2016) is the German translation of Hans Zweifel et al., Plastic Additives Handbook, 6th edition, ISBN 978-3-446-40801-2, Chapter 2.

[5] Please note that some companies/company sites reported more than one type of use (industrial, commercial, consumer).

FDA, 2021). In Japan, UV-328 is in the 2020 Positive List for food contact plastics additives (MHLW, 2020). In China, UV-328 is included in the list of additives for plastic food contact materials and articles (NHFPC, 2016).

49. In the EU suppliers of articles containing UV-328 in a concentration above 0.1% w/w need to submit information on these articles from 5 January 2021 to the SCIP database (Substances of Concern In articles as such or in complex objects (Products))[6] established under the Waste Framework Directive. By 1 March 2022 the total number of factsheets (entries) related to UV-328 in the SCIP database was 315,251. According to the data supplied by the companies, UV-328 by itself is mainly used in motor vehicles, including motorcycles, and their components and accessories, including seats (≥ 65,720 registered factsheets) followed by components and accessories of optical, photographic, cinematographic, medical, surgical or veterinary's instruments and apparatus, as well as measuring instruments and apparatus; including liquid crystal devices, sheets and plates of polarizing material, oxygen therapy, aerosol therapy, artificial respiration or other therapeutic respiration apparatus and other breathing appliances (≥ 4,993), Components and accessories of optical, photographic, cinematographic, medical, surgical or veterinary's instruments and apparatus, as well as measuring instruments and apparatus; including liquid crystal devices, sheets and plates of polarizing material, oxygen therapy, aerosol therapy, artificial respiration or other therapeutic respiration apparatus and other breathing appliances (≥ 1,826), plastics and plastic articles, including self-adhesive plates, sheets, film, foil, tape, strip and other flat shapes, of plastics, whether or not in rolls (≥ 1,570) and other products (≥ 645). In mixtures that are incorporated in motor vehicles, including motorcycles, and their components and accessories, UV-328 is mainly used in adhesives and sealants (≥ 53,536) and paints and coatings (≥ 47,131) but also in fiber, leather, rubber and polymerized materials preservatives (≥ 875) and in gypsum (≥ 620). In addition, suppliers of articles have notified to SCIP UV-328 as being present in the following materials in articles: Plastic (and polymers), e.g., polyurethanes, poly(methyl methacrylate), polycarbonates, including copolymers, soft polyvinylchloride, (co)polymers of olefins, other acrylic (co)polymers, rubber and elastomers and other (Annex F EU, 2022).

50. According to the Association of the Adhesives Industry in Switzerland, their members that participated in the survey are not intentionally adding UV-328 to adhesive formulations, neither as a raw material nor as an additive. They claim that based on the best of their knowledge and the information obtained from their raw material suppliers, UV-328 should not be present in their adhesive formulations in considerable concentrations, except traces on the level of natural or technical impurities. However, specific analyses to measure UV-328 have been neither performed on their raw materials nor their products themselves.

51. UV-328 is furthermore used in cooling liquids in refrigerators, in oil-based electric heaters, hydraulic liquids in automotive suspensions and in lubricants in motor oil and break fluids. Due to it being a UV absorber, it is especially used in outdoor products made from wood and plastic. However, it can also be found in indoor products such as furniture, toys, construction materials, leather products, footwear, paper and cardboard articles, flooring and electronic equipment (Denghel, 2021).

52. UV-328 has been reported to have three main uses in the automobile sector: 1) in optical polarizing plate and polarizing film for liquid crystal panels (of the super twisted nematic type) and meters mounted on vehicles, 2) in paint and 3) in resin used for interior and exterior parts (e.g. door handles and levers) (JAPIA, 2021).

53. The European Automobile Manufacturers' Association (ACEA) estimated the possible amount of legacy spare parts (LSPs) containing UV-328 as well as the amount of UV-328 contained in these LSPs (Annex F ACEA, 2022). ACEA highlights that the information is related to significant uncertainties. According to their estimation, the most relevant quantities of UV-328 in LSPs are to be expected in components such as bumper systems, radiator grills, spoilers, car garnish, roof modules, soft/hard tops, trunk lids and rear window wipers (in decreasing order of relevance), but also in polarizing films of interior displays. Of note, these parts are mostly rather large plastic components, some of which are also painted. These are usually exterior vehicle parts that are exposed to light and therefore typically contain a light stabilizer. Based on the estimation provided by ACEA, it can be derived that more than 99% of UV-328 sold in LSPs may be contained in bumper systems and radiator grills. Based on the feedback provided by ACEA and automotive associations in North America and Japan, UV-328 will be phased out in the mass production latest by 2025.[7] Furthermore, spare part applications will automatically phase out over time due to the continuous replacement of older vehicles with newer ones. Apart from automobiles (including motorcycles), legacy parts and spare parts containing UV-328 are used for industrial machines (agricultural machinery, construction machinery, medical equipment, electric and electronic instruments) (Annex F Japan, 2022).

54. In coatings, the typically recommended concentration of UV-328 is between 1 and 3% (by weight, based on solids) (Hangzhou Sunny Chemical Corp Ltd., 2003). For the consumer use in automotive clearcoat finish and topcoat glaze for boats, concentrations of UV-328 ranging up to 10% were identified in material safety data sheets in the USA

[6] https://echa.europa.eu/scip-database

[7] Personal Communication ACEA, 12.04.2022.

(as reported in ECCC and Health Canada, 2016). In resin and paint used in the automotive sector UV-328 concentrations range between 0.1 and 1% (JAPIA, 2021).

55. In plastics, the recommended loading of UV-328 as an additive during manufacturing is typically 0.1–1% by weight(Hunan Chemical BV, 2016). Polymer-specific recommendations are 0.15–0.3% for PC, 0.2–0.4% for polyethylene (PE), 0.2–0.5% for PS and PVC and 0.3–0.5% for polyesters (Disheng Technology, 2017).

56. Several studies have found UV-328 in plastics and packaging materials (Chang et al., 2013; Rani et al., 2017; Zhang et al., 2016). Zhang et al. (2016) found UV-328 in the range of 25–76 µg/g (0.0025–0.0076% by weight) in milk packaging and snack packaging together with other UV absorbers. Chang et al. (2013) reported a concentration of 2.01 µg/g of UV-328 in commercial polyethylene terephthalate (PET) beverage packaging and 13.88 µg/g in low-density polyethylene (LDPE) packaging. Rani et al. (2017) reported concentrations in the range of 0.0027–0.4 µg/g in newly-produced plastics. In addition, UV-328 has been detected in recycled post-consumer PET intended for subsequent manufacturing of food contact materials, although the concentration of UV-328 was not reported (Dutra et al., 2014).

57. Brosché et al. (2021) analyzed 24 samples of plastic pellets sold as high-density polyethylene (HDPE) and collected from 23 mostly developing countries around the world from local recycling industries for the presence of UV-328. UV-328 was detected in 17 of the 24 samples (71 % of samples) in concentrations ranging between 0.102 and 334 µg/kg. Other UV-stabilizers such as UV-234, UV-326, UV-327 and UV-329 were also detected. The limit of detection (LOD) was 0.03 µg/kg (Brosché et al., 2021).

58. For the use of UV-328 in textiles, it is not known what the typical loading of UV-328 is. Avagyan et al. (2015) measured UV-328 in various clothing articles. From 26 clothing articles made from different materials, UV-328 was detected at concentrations of 8.05 and 108 ng/g in two samples composed primarily from cotton.

59. In summary, UV-328 is used as a UV absorber and based on the available information, the main uses are in plastics such as PP, PS, PVC, PU and rubbers used in the automotive industry, such as, automotive paints, coatings, sealants, adhesives, plastics and rubbers to protect materials from UV light-induced degradation or color-change, as well as various automotive fluids, such as, cooling and hydraulic liquids, and lubricants in motor oil. It can also be used as additives and printing inks in the plastics and rubbers for outdoor furniture, construction materials and food packaging in and wood products. Other uses also include applications in leather and textiles as well as cosmetics. Use concentrations range from 0.1 to 10% by weight.

Sources for releases

60. UV-328 may be released to the environment during all life cycle stages. This includes the release from point sources during production, manufacturing, transportation and final use of the substance as well as during the use, disposal and end of life treatment of products containing UV-328 (Bolgar et al., 2016). No empirical data are available that quantify the main releases of UV-328 from different sources to the environment. However, the Canadian assessment of UV-328 provides estimates on the releases of UV-328 to surface waters due to the industrial uses of UV-328 in the plastics manufacturing sector and the paints and coatings sector in Canada, and predicted environmental concentrations (PEC) in surface waters, sediment, biosolids (sewage sludge) and soil under different release scenarios, which are summarized in Table 3 and Table 4. Additional details on how the PECs were calculated in the Canadian assessment are available in UNEP/POPS/POPRC.17/INF/17. After its release to surface waters, UV-328 likely partitions to particles and organic matter, and ends up in sediment (ECCC and Health Canada, 2016).

Table 3: Predicted environmental concentrations resulting from releases of UV-328 due to industrial uses in the plastics sector. A use of 25 tonnes per facility per year is assumed[8]. Source: ECCC and Health Canada, 2016**.**

	Site specific	Generic
Surface waters near the discharge point (short-term concentration) (mg/L)	$2.52 \cdot 10^{-4}$	$1.28 \cdot 10^{-4} – 8.81 \cdot 10^{-3}$
Surface waters in receiving water bodies (long-term concentration) (mg/L)	$6.90 \cdot 10^{-6}$	$3.52 \cdot 10^{-6} – 2.41 \cdot 10^{-4}$
Sediment (mg/kg dw)	0.19	6.80
Biosolids (mg/kg dw)	18.62	2446.23
Soil (mg/kg dw)	0.64	84.60

[8] Further details on the input to the calculations are available in UNEP/POPS/POPRC.17/INF/17.

Table 4: Predicted environmental concentrations resulting from releases of UV-328 due to industrial uses in the paints and coatings sector. A use of 12 tonnes per facility per year is assumed[9]. Source: ECCC and Health Canada, 2016.

	Site specific	Generic (solvent-based coating)	Generic (aqueous-based coating)
Surface waters near the discharge point (short-term concentration) (mg/L)	$4.92 \cdot 10^{-5}$	$2.67 \cdot 10^{-6} – 7.78 \cdot 10^{-4}$	
Surface waters in receiving water bodies (long-term concentration) (mg/L)	$1.35 \cdot 10^{-6}$	$7.31 \cdot 10^{-8} – 2.13 \cdot 10^{-5}$	
Sediment (mg/kg dw)	0.038	0.14	0.60
Biosolids (mg/kg dw)	92.42	1016.62	84.72
Soil (mg/kg dw)	3.20	35.16	2.93

61. Findings from monitoring studies conducted in Narragansett Bay, Rhode Island, USA, also implicated industrial releases as a source of UV-328 in the environment, where sediment cores showed high levels of UV-328 corresponding to the years (1970–1985) during which UV-328 was being produced in a nearby facility (Cantwell et al., 2015; Hartmann et al., 2005; Jungclaus et al., 1978; Lopez-Avila & Hites, 1980).

62. The discharge of products containing UV-328 into waste streams is relevant for the detection of UV-328 in different environmental compartments such as oceans, rivers, beaches, sediment and soil. This is because UV-328 is not chemically bound to materials, which implies that processes such as abrasion, leaching and volatilization may result in the release of UV-328 from products into the environment. Wastewater treatment plants, landfills and storm water are therefore considered to be sources for the release of UV-328 to the environment (Brorström-Lundén et al., 2011; Montesdeoca-Esponda et al., 2021).

63. According to Norway, emission of UV-328 to both the indoor and outdoor environment has been observed. UV-328 has been detected in indoor air and dust, wastewater, wastewater sludge, river water and biota in source regions and in biota in remote regions (Annex E, 2021). The detection of UV-328 in indoor dust and air as well as in various environmental matrices and biota in Norway further indicates a release from products during the product lifetime as well as during the waste stage (Annex F Norway, 2022).

64. Releases of UV-328 from indoor use are likely to occur from machine wash liquids and detergents as well as fragrances and air fresheners (ECHA, 2022a). Thus, according to the International Pollutants Elimination Network (IPEN) and the Alaska Community Action on Toxics (ACAT), it seems likely that UV-328 is used in products that would contribute to direct emissions into the environment (Annex F IPEN and ACAT, 2022). This statement is further supported by the uses listed in Denghel (2021).

65. UV-328 is expected to enter soil from the application of wastewater biosolids (Lai et al., 2014) and as a result of the degradation of disposed products that contain UV-328 (ECCC and Health Canada, 2016). Agricultural plastics use might be another source of UV-328 to the soil.

66. As detailed above, a major use of UV-328 is as an additive in plastics. Currently there are no data quantifying the release of UV-328 from consumer plastic products into the environment. It is known that significant amounts of plastics are released to the oceans (18.6–26.1 Mt) every year and these originate both from terrestrial and ocean-based sources (Borrelle et al., 2020; Ryan et al., 2009). Once in the open ocean, plastic debris is known to accumulate within each of the ocean gyres where a significant accumulation occurs as well as in the Arctic (Bergmann et al., 2022; Eriksen et al., 2014). Plastic debris containing UV-328 in the accumulation zones of the gyres may therefore act as sources of release of UV-328 to receiving environments. UV-328 has been detected in a fraction of marine plastic debris at maximum concentrations of 0.2–1.6 µg/g (Rani et al., 2015; Tanaka et al., 2020), as well as in plastics ingested by seabirds such as northern fulmar and black-footed albatross (Tanaka, van Franeker, et al., 2019) and in other seabirds that feed in the open ocean and are known to frequently ingest fragments of marine plastic debris (Tanaka, Yamashita, et al., 2019; Yamashita et al., 2021). Data from Canada indicate that Arctic seabird species that show a higher frequency of occurrence of any ingested plastics may be more exposed to UV-328 as compared to species that have very low or negligible levels of ingested plastics. Plastic litter containing UV-328 may therefore be a relevant entry pathway of UV-328 in the marine environment and an exposure pathway for biota that ingest plastics (Provencher et al. submitted for publication 2022; Yamashita et al., 2021).

[9] Further details on the input to the calculations are available in UNEP/POPS/POPRC.17/INF/17.

67. Additionally, UV-328 was detected in 101 of 110 samples of weathered industrial plastic pellets collected along beaches of 22 countries around the world, however it cannot be distinguished whether it is adsorbed or in the matrix. The concentrations ranged from 2 to 800 ng/g (Karlsson et al., 2021, 2022).

68. The use of UV-328 in textiles can also be a source of releases of UV-328 to the environment and wastewater treatment plants when textiles are washed. It was shown that after 10 wash cycles, as much as 80% of UV-328 was removed from textiles made from polyesters (Luongo et al., 2016).

Relevance of releases

69. As stated in the Risk Profile (UNEP/POPS/POPRC.17/13/Add.3), there are currently no data quantifying the release of UV-328 from consumer plastic products into the environment. Based on the Canadian assessment of UV-328, the losses to wastewater from the plastics sector range between 0.211 % in the specific scenario and 0.231 % in the generic scenario (ECCC and Health Canada, 2016). Considering an annual usage of 25 t of UV-328 at the industrial site, this would result in a total annual loss of ca. 53 kg or 58 kg of UV-328 to wastewater depending on the respective scenario. Thereof, a large fraction (82.6%) of UV-328 is removed by off-site wastewater treatment plants (WWTPs), where UV-328 sorbs to biosolids. This suggests that the largest share of UV-328 released from industrial sites is caught in the sludge of the WWTPs (ECCC and Health Canada, 2016). In the paints and coatings sector, dust losses during material handling are indicated as 0.2 % (for solvent- and aqueous-based coating) and losses to wastewater due to vessel cleaning as 0.5 % (for aqueous-based coatings) (ECCC and Health Canada, 2016). Considering an annual usage of 12 t of UV-328 at the industrial site (solvent-based coating), this would result in 24 kg dust loss. In the case of aqueous-based coatings (1 t/a usage volume at the production site), this would result in 5 kg of loss to wastewater and 2 kg of dust loss. The allowance for the removal of dust by the ventilation system is 95 % (ECCC and Health Canada, 2016).

70. In conclusion, releases of UV-328 occur during all life cycle stages due to past and present production, manufacturing, transportation and final use of the substance as well as during the use, disposal and end of life treatment of products containing UV-328. Production and manufacturing sites of UV-328 are source of releases. As UV-328 is not chemically bound to materials, the substance may be released from products and enter the environment, indicating the importance of the use and waste phase. Particular attention should be given to plastic litter containing UV-328 which might represent the main source of UV-328 in the marine environment and for biota ingesting plastics. Other sources of release include machine wash liquids, detergents, fragrances and air fresheners as well as textiles. In general, there is a lack of quantitative data on releases of UV-328. Release estimates for the industrial use of UV-328 in the plastics industry indicate losses to wastewater which mainly end up in sewage sludge of WWTPs due to its high affinity to adsorb onto organic particles. Hence, the application of sewage sludge to land may be another source of release of UV-328 to the environment.

2.1 Identification of possible control measures

71. The control measures may be achieved in different ways under the Convention:

(a) UV-328 may be listed in Annex A, with or without specific exemptions; or

(b) UV-328 may be listed in Annex B, with acceptable purposes/specific exemptions; and/or

(c) UV-328 may be listed in Annex C as an unintentional persistent organic pollutant to capture potential formation and unintentional release from anthropogenic sources. This is, however, not considered a relevant control measure since the substance is not unintentionally produced.

72. Possible control measures may include: (1) prohibition of production, use, import and export; (2) replacement of the chemical by alternatives; (3) environmentally sound disposal of waste and prohibition of reuse and recycling of wastes or stockpiles in accordance with Article 6(1)(d) of the Convention; (4) control of discharges or emissions; (5) clean-up of plastic debris from marine and other environments; (6) clean-up of contaminated sites; (7) environmentally sound management of obsolete stockpiles; (8) establishment of exposure limits in the workplace; and (9) establishment of thresholds or maximum residue limits in water, soil, sediment or food.

73. As the aim of the Stockholm Convention is to protect human health and the environment from POPs, the most effective measure would be to list UV-328 in Annex A to the Convention, banning the production, use, import and export with no exemptions for production and use. If listed in Annex A or B, stockpiles and wastes containing UV-328 would be subject to the provisions in Article 6 of the Convention and would have to be managed in an environmentally sound manner.

74. If UV-328 would be listed in Annex A, the availability of alternatives for its uses should be identified. Safer alternatives should be pursued and it should be assessed whether there are critical uses where no alternatives are available. Such uses may be considered for a specific exemption. When discussing exemptions, transition periods for uses which can be substituted in the future should be discussed. Possible exemptions might include LSPs in the

automotive sector (for further explanation see paragraph 88). Such an exemption was made available for another POP-plastic additive, namely decaBDE. However, specific exemptions should be as narrow as possible and based on clear evidence.

75. If UV-328 is listed to the Convention, waste containing this substance at or above the low POP content should, in accordance with Article 6, paragraph 1(d)(ii), be disposed of in such a way that the POP content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of POPs or otherwise disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option. In accordance with Article 6, paragraph 1(d)(iii), such waste is not permitted to be subjected to disposal operations that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of persistent organic pollutants. To enable destruction or irreversible transformation of the UV-328 content of waste and to avoid recovery, recycling, reclamation, direct reuse or alternative uses, the materials containing UV-328 should therefore be separated from waste streams. In a circular economy, the general intention is to recycle wastes to the greatest extent possible. However, to avoid possible risks, POPs and other hazardous substances should not be spread through recycling and should rather be separated from waste streams intended for recycling. As such a prohibition of the reuse and recycling of UV-328 containing wastes and stockpiles can be a useful measure to prevent the further spread of UV-328. However, when products are entering the waste stream, it is not always clear whether they contain UV-328 and they may be difficult to separate. For separation, it is important to know which products and/or components contain UV-328.

76. Production and manufacturing sites are a source of UV-328 into the environment (ECCC and Health Canada, 2016; Jungclaus et al., 1978; Lopez-Avila & Hites, 1980). To control emissions during production, transport and waste management of UV-328, all applicable best available techniques (BAT)/best environmental practices (BEP) measures should be applied. If the production and use of UV-328 is banned after listing in Annex A with no specific exemption, such measures related to UV-328 are no longer needed, as no emissions and/or discharge can occur during production, manufacturing and transport. However, if the use in spare parts is exempted, the substance would have to be produced and relevant BAT/BEP would have to be applied. As UV-328 is not covalently bound to the polymer matrix it can be continuously released from the product during the use and waste phase via abrasion, volatilization and leaching. However, no empirical data are available that quantify the releases of UV-328 from different sources to the environment. Since releases occur in all life cycle stages, appropriate emission control measures should be implemented at all stages where technologically feasible.

77. As indicated in the risk profile (UNEP/POPS/POPRC.17/13/Add.3) marine plastic litter is a source of UV-328 in the environment and may lead to accumulation in biota via ingestion by migratory birds and other animals and subsequent leaching in their stomach (Karlsson et al., 2021; Rani et al., 2017; Tanaka et al., 2020; Yamashita et al., 2021). A clean-up of marine plastic litter can reduce the releases of UV-328 from this source.

78. Through the production and disposal of UV-328 and relevant products there might be contaminated sites. High UV-328 concentrations in river water close to a facility which produced UV-328 between 1970 and 1985 indicates local contamination at (legacy) production sites (Jungclaus et al., 1978). Leachate from landfills in Sweden has been found to contain UV-328 (Brorström-Lundén et al., 2011), highlighting that the substance can leach into the soil and water in and around landfills. Contaminated sites should be identified and may undergo environmentally sound remediation efforts.

79. Relevant stockpiles of UV-328 should be managed in a safe, efficient and environmentally sound manner. In accordance with Article 6, each Party shall, to the extent practicable, identify remaining stockpiles and dispose of them in such a way that the POPs content is destroyed or irreversibly transformed.

80. UV-328 has been detected in human adipose tissue and breast milk in various parts of the world. According to the risk profile (UNEP/POPS/POPRC.17/13/Add.3), in humans, exposure to UV-328 can occur via ingestion/inhalation of contaminated dust as well as consumption of contaminated fish and other seafood. If relevant exposure takes place at specific workplaces, e.g., in production and manufacturing of UV-328 and materials and products containing the substance, the establishment of specific exposure limits in the workplace could reduce human exposure. However, there is no specific information on relevant exposure at workplaces. No control measures are considered in this respect, because if the substance is listed in Annex A, workplace exposure during production and manufacturing would no longer be a significant exposure route.

81. Thresholds or maximum residue limits in water, soil, sediment or food can be established to control the exposure of the substance to humans and the environment and to take appropriate measures to reduce exposure. Due to its high log K_{OC} and log K_{OA}, UV-328 has been detected in sediment samples oftentimes in concentrations above 1 µg/g dw (Brorström-Lundén et al., 2011; Lopez-Avila & Hites, 1980). Limit values for UV-328 concentrations, e.g. in soil or sediment might help to control and lower the exposure through sediment.

82. In general, when assessing the control measures, consideration should be given to all sources of exposure and releases described in section 26, including production and manufacturing as well as the use and the waste

management of articles containing UV-328. In conclusion, prohibition of production, use, import and export and the replacement of the chemical by alternatives could be particularly relevant control measures. Further, the disposal of waste containing UV-328 at or above the low POP content value in such a way that the POP content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of POPs, or otherwise disposed of in an environmentally sound manner; the prohibition of reuse and recycling of wastes or stockpiles; the clean-up of plastic debris from marine and other environments and of contaminated sites; and the environmentally sound management of obsolete stockpiles are considered additional appropriate control measures.

2.2 Efficacy and efficiency of possible control measures in meeting risk reduction goals

83. As UV-328 travels across borders as indicated in the risk profile (UNEP/POPS/POPRC.17/13/Add.3), solely national control measures do not prevent damage caused by emissions of UV-328. The substance is emitted throughout the whole life cycle, which would require necessary control measures for each stage. As such, a listing in Annex A prohibiting production, use, import and export without exemptions would be the most effective measure to prevent the further spread and resulting damage. This is especially important for developing countries that lack adequate regulatory and enforcement infrastructure (Annex F IPEN and ACAT, 2022). Since releases occur during the whole life cycle, environmentally sound management of stockpiles and wastes containing UV-328 are also essential. Listing in Annex A would be efficient in covering the whole life cycle, since in accordance of Article 6 of the Convention, also stockpiles and wastes would have to be managed in an environmentally sound manner.

Prohibition of production, use, import and export and replacement of the chemical by alternatives

84. In order to evaluate the efficacy and efficiency of the replacement of the chemical by alternatives, it would be required to assess whether there are any uses that are needed by society and for which an environmentally and economically suitable chemical and/or non-chemical alternative may not be available. For such critical or essential uses specific and time-limited exemptions could be provided in Annex A to the Convention.

85. The availability of alternatives needs to be evaluated for all the different uses. As UV-328 was identified as a substance of very high concern (SVHC) in the EU, an authorization will be required to continue the use in their territory. One EU supplier of the substance stated that they will supply the substance until this authorization requirements comes into effect. However, the supplier will not apply for authorization, as there are several viable alternatives to UV-328 which are not identified as SVHC. The supplier, however, stated that some of the downstream users, e.g., the automotive industry might submit an application for authorization, as the recertification process for (spare) parts requires much time and resources. Another co-registrant made the same statement referring to the numerous readily available alternatives, which were not benzotriazoles (ECHA, 2020). Depending on the specific requirements of the final plastic application, alternative chemistries are available to stabilize plastics. However, each UV absorber has its specific substance properties. Therefore, the selection of a replacement candidate must be evaluated in order to avoid reduction of the specified product performance.[10]

86. In a recent study by Wiesinger et al. (2021) different kinds of plastic additives were mapped based on their function, associated polymer and sector of use. In this study a total of 762 light stabilizers were identified. While not every light stabilizer is a UV absorber but can also include, e.g., stabilizers and quencher, the data indicates a wide variety of available alternatives, as many of the light stabilizers are used in similar polymers and applications as UV-328. It should be noted that of these light stabilizers, 47% are of medium or high concern[11] and that alternatives should be selected carefully to avoid regrettable substitution. On the other hand, 53% of the light stabilizers are categorized as having an unknown[12] or low level of concern (Wiesinger et al., 2021).

87. Information on specific uses where chemical or non-chemical alternatives are not available could not be identified. Specific information on alternatives is provided in section 2.3 of the present risk management evaluation.

88. The European Automotive Industry represented by ACEA has argued that an exemption for legacy spare parts (LSPs) will be needed. ACEA explains that the substitution of UV-328 in LSPs will not be feasible, in particular for

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[10] Comment ELiSANA (European Light Stabilisers and Antioxidants Association) on 1st draft risk management evaluation referring to Hans Zweifel et al., Plastic Additives Handbook, 6th edition, ISBN 978-3-446-40801-2, Chapter 2.

[11] In Wiesinger et al. (2021), substances that fulfil one or more of the following hazard criteria under EU REACH were identified as substances of potential concern: PBT/vPvB, carcinogenicity (C), mutagenicity (M), reproductive toxicity (R), endocrine disruption (ED), specific target organ toxicity upon repeated exposure (STOT-RE), and chronic aquatic toxicity.

[12] Within the study of Wiesinger et al. (2021), substances with insufficient hazard information or without any information at all in the considered regulatory databases were classified as “unknown”.

vehicles which are no longer in mass production or where the manufacturing of spare parts has ceased, and spare parts have been put on stock. Their request is related to the testing requirements (e.g., safety, durability and crash testing) which need to be fulfilled to ensure the required performance of the material in the vehicle (Annex F ACEA, 2022). Due to the time-consuming testing requirements, the substitution process requires at least 5 years for new products, while a safe substitution in LSPs is not economically or technically feasible. This is especially the case, if component production has been transferred to small and medium-sized enterprises (SMEs) as they lack information on component performance requirements (Annex F ACEA, 2022). Therefore, assuming that a listing of UV-328 under the Convention would enter into force at the earliest in 2026[13] ACEA asks for an exemption only for legacy spare parts. According to ACEA, without the requested derogation, it is likely that manufacturers of spare parts will stop their manufacture, which can ultimately lead to unavailable or untested spare parts and thus dangerous replacement parts. In addition, spare parts of industrial machines (agricultural machinery, construction machinery, medical equipment, electric and electronic instruments) face a similar situation. In a worst case, motor vehicles and industrial machines may not be repairable and thus would have to be wasted (Annex F ACEA, 2022; Annex F Japan, 2022). A similar specific exemption has been made available for decaBDE (see Annex A, part IX of the Convention) and could be considered for UV-328 as well. Therefore, considering an entry into force by the end of 2024, a possible exemption could be given to vehicles that have been type approved/certified prior to January 2025 and spare parts of those motor vehicles and industrial machines.

Environmentally sound disposal of waste and the prohibition of reuse and recycling of wastes or stockpiles

89. Introducing waste management measures, including measures for products and articles upon becoming waste, in accordance with Article 6 of the Convention, would ensure that wastes containing UV-328 at concentrations at or above a low POP content are disposed of in an effective and efficient way such that their POPs content is destroyed or irreversibly transformed, or otherwise disposed of in an environmentally sound manner. These measures would also address proper waste handling, collection, transportation and storage and ensure that emissions and related exposures to UV-328 from waste are minimized. Establishment of the low POP content and the guidelines, which would be developed in cooperation with the Basel Convention, would help Parties to dispose of waste containing UV-328 in an environmentally sound manner. General technical guidelines on the environmentally sound management of POP-wastes have been developed under the Basel Convention and can be used as a first reference[14]. A specific technical guideline would be prepared addressing also waste containing UV-328, if it is listed to the Convention. The specific technical guideline will contain in its section I.B.4 information on wastes and waste streams containing UV-328 and in its section IV.G.2. information on destruction and irreversible transformation methods.

90. As one of the main uses of UV-328 is as an additive in plastics, there is a high potential for it to be reintroduced into the economic cycle via the recycling of plastics with the effect that it continuously contributes to releases of UV-328. It has already been found in recycled HDPE in concentrations up to 334 µg/kg (Brosché et al., 2021). The substance has also been identified in recycled PET destined for the use in food contact material (Dutra et al., 2014). As the world wide share of recycled plastics is increasing (Ritchie & Roser, 2018), more and more potentially hazardous additives can be recycled into new products. Additionally, the more products made from recycled plastics are placed on the market, the harder it will become to identify wastes containing UV-328. Therefore, a prohibition of the recycling of material containing UV-328 would contribute to reducing risks for human health and the environment.

91. UV-328 containing waste should be managed in an environmentally sound manner in accordance with Article 6.1.(d) of the Convention. To enable destruction or irreversible transformation of the UV-328 content of waste and to avoid recovery, recycling, reclamation, direct reuse or alternative uses, the materials containing UV-328 should therefore be separated from waste streams. The occurrence of UV-328 in recycled material, however, demonstrates the difficulty of separating plastics containing UV-328. Plastic products entering the waste phase are either manually dismantled or shredded. Plastics intended for recycling or disposal are separated. During the separation steps the plastics intended for recycling are typically separated into distinct polymer types (e.g., PE, PP, PS, etc.) via appropriate processes including, e.g., density-, electrostatic- and sensor-based separation. This typically yields a light fraction of plastics intended for recycling such as PE, PP and PS. The heavy fraction, on the other hand, often includes plastics with additives which are considered pollutants such as halogenated flame retardants, mineral fillers and impurities like metal and glass and as such is effective in separating other POPs such as PBDEs, HBCD and SCCPs (Martens & Goldmann, 2016). These specific POPs contain heavy halogens and can therefore be identified and separated during the recycling processes e.g., via X-ray fluorescence or density separation. An adequate separation of these POP-containing materials is possible with current waste treatment technology, however, not all countries apply

[13] It is, however, noted that the listing to Annex A might enter into force as early as December 2024.

[14] Available at
http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/

current technology and as such may not be able to separate POP-containing fractions. UV-328 does not contain easily detectable or separable atoms such as halogens, phosphorous or sulphur and as such the current technologies for the waste treatment sector might not be able to efficiently identify and separate UV-328 containing plastics from the waste stream. No specific method for the separation of UV-328 containing plastic could be identified in current literature. Possible techniques might include the detection of UV-328 via photoelectric sensors based on UV-spectroscopy or solvent based recycling of plastics in which the additives can be removed as precipitation (Hubert, 2019). Such techniques are however not established and the ability to separate UV-328 at industrial scale is not confirmed. Further research is needed for an appropriate waste treatment regarding the separation of UV-328 containing plastics.

92. Accordingly, the UK notes that there are likely to be technical difficulties involved in identifying waste containing UV-328 to enable it to be removed and appropriately destroyed and claims that, if no technology for the separation of UV-328 containing plastic exists, it may require the incineration of high risk waste streams, which would be associated with high costs (Annex F UK, 2022). The likelihood of identification and/or sorting of contaminated waste streams will be challenging and, if it's not known precisely which articles contain UV-328, will most likely result in increased incineration of plastics. This could be costly to implement and reduces the supply of recycled plastics.[15]

93. In some cases, plastic parts can be separated before a shredding process. This is typically done in order to create waste streams with little to no impurities to simplify the recycling process. In the automotive sector bumpers and radiator grilles are examples of such parts which may contain a very relevant share of UV-328 contained in vehicles. Based on the estimation provided by ACEA these two components may contain more than 99% of the UV-328 contained in LSPs. It should be noted that in cars not only spare parts but also particularly paints/coatings and adhesives/sealants contain UV-328. Bumpers and radiator grilles are comparatively easy to dismantle. However not all bumpers and radiator grilles contain UV-328 and would need to be identified and separated from those containing UV-328. For this, suitable identification methods would be needed.

94. Another relevant use of UV-328 is in paints and coatings as well as in adhesives and sealants, especially used in automotive and wood applications. Wood which contains, e.g., paints, varnishes, veneers, finishing products etc. containing UV-328 poses a problem during wood recycling. As these products should not be recycled, they are most commonly incinerated, however, they may also be landfilled in certain countries (Besserer et al., 2021). In cars the most common application of coatings is on the metal parts such as the roof, doors and hood. These parts are typically shredded, separated via magnet and sent to metal recycling plants. In the automotive sector more than 90% of all steel is recycled worldwide (WorldAutoSteel, 2022). During the recycling of metal, the scrap metal is molten and mixed with virgin material. During this process very high temperatures above 1000 °C are applied (UNEP, 2013), which likely destroys UV-328 (decomposition temperature ~180 °C (ECHA, 2022b)). Paints, coatings, sealants and adhesives may however also flake off during the shredding process and end up in the shredder heavy or light fraction depending on the size of the flake. During the subsequent treatment steps of those two fractions the flakes are expected to be sorted out and are typically incinerated. Hence, the recycling of coated metal from the automotive industry is not seen as a relevant source of UV-328 in recycled products. This is, however, an assumption based on available data and needs to be supported by scientific evidence. Technologies for the destruction and irreversible transformation of UV-328 in wastes will be evaluated by an expert group jointly with the Basel Convention.

95. As UV-328 is also present in many other products, it can be present in many different waste streams, making it difficult to eliminate it from each relevant waste stream. A possible solution is to create an inventory of common waste containing UV-328. This might assist Parties as well as industry in identifying waste fractions and separable parts that may contain UV-328. Such an inventory can lead to a better pre-separation and more efficient separation of the substance. An example of a database that potentially could be used for that purpose is the European SCIP database which requires companies supplying articles containing substances of very high concern (SVHCs) in a concentration above 0.1% weight by weight (w/w) on the EU market to submit information on these articles to ECHA. Additionally, the International Dismantling Information System (IDIS) contains information, such as the material and size, about the specific parts of a certain vehicle model. Manufacturers compile this information about their vehicles which may then be used by waste facility operators to identify potential products and parts in waste streams. Similar information on the use of hazardous substances in automobiles can also be found in the international material data system (IMDS).

96. The destruction of UV-328 containing waste in accordance with Article 6 of the Convention is seen as the most efficient way of ensuring no further spread and emission of the substance from waste. As UV-328 decomposes at temperatures below 200 °C (ECHA, 2022b), it can be assumed that it is completely destroyed in appropriate waste incineration facilities. As UV-328 does not contain halogen atoms, PCDDs/PCDFs or PBDDs/PBDFs or other halogenated POPs do not arise from its incineration. However, POPs may be formed from a halogenated material that

[15] Comment UK on 1st draft risk management evaluation

contains UV-328. This needs to be supported by scientific evidence. Technologies for the destruction and irreversible transformation of UV-328 in wastes will be evaluated by an expert group jointly with the Basel Convention.

97. Other waste treatment options include landfilling in specially engineered landfills and underground storage (Basel Convention, 2019b). However, landfilling has the downside of not destroying the UV-328 content of the waste. UV-328 has been detected in landfill leachate (Brorström-Lundén et al., 2011), proving that the substance can leach out of the product and into the waste water when disposed in a landfill. Landfilling is currently the most common waste treatment method with 70% of the world's waste being disposed of in landfills (Chen et al., 2020). This leads to an accumulation of UV-328 containing waste in landfills, which can lead to further emissions into the environment. Waste containing UV-328 at or above the low POP content limit, to be identified if UV-328 is listed under the Convention, should only be disposed of in a specially engineered landfill, designed to prevent leaching as described in the corresponding Basel Convention technical guideline (Basel Convention, 2019a). Wastes with concentrations below the low POP content limit should be disposed of in an environmentally sound manner in accordance with national legislation. Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with UV-328 will be developed by an expert group jointly with the Basel Convention.

98. Some landfill leachates are treated on-site at the landfills. However, in other cases it is routed to a waste-water treatment plant (WWTP), where it is mixed with the other incoming water streams. When arriving in a WWTP, UV-328 quickly adsorbs to the solid phase due to its high log K_{OC} value and can be ultimately found in the sludge phase after the treatment. As a result UV-328 has been found in sludge samples (Brorström-Lundén et al., 2011; Montesdeoca-Esponda et al., 2021) However, findings in the effluent indicate that while the major fraction binds to the solid phase, a minor fraction remains in the water (Haruhiko et al., 2010). The effluent is typically directly released to surface waters or used on land for irrigation (Drechsel et al., 2015). Hence, WWTPs can be point sources of UV-328 into the environment. A significant fraction of the globally produced sludge is used for agricultural purposes or disposed of in landfills (Buchauer, 2019), which in the first case is a direct application of UV-328 on land and in the second case can lead to the leaching of UV-328 from the landfill. In many countries the dried sludge is incinerated (Drechsel et al., 2015) and the contained UV-328 is destroyed. In general, sludge containing UV-328 concentration at or above the low POP content limit should be disposed of in an environmentally sound manner in accordance with Article 6 of the Convention. This can be disposal in a landfill as well as via incineration. The incineration of sludge can be considered the preferred option, as other harmful substances including other POPs are destroyed, too.

99. In order to address each individual waste stream arising from an exempted use of UV-328 in LSPs, extended producer responsibility policies could be implemented. Such policies extend the responsibility of the producer also to the waste stage of their sold products and can help countries manage the wastes arising from the use of UV-328 and other POPs.

100. Often waste is exported to countries which do not have sufficient capacities to dispose of them in an environmentally sound manner. Many developing countries do not have the economic means to build the necessary infrastructure for the sound treatment of such waste. Vehicles are for example left at the roadside, disposed of illegally or dismantled for spare parts by the informal sector and subsequently sold on the second hand market for material recovery and recycling. However the recycling capacities in these countries are often lacking leading to improper disposal (Numfor et al., 2021) and the potential spread of POPs and other toxic substances. In Africa the per capita consumption of plastics is 16 kg leading to a total consumption of 19.5 Mt in 2015, which also includes textiles, electric and electronic appliances, packaging etc. However the plastic materials are often subject to illegal dumping and open burning in landfills or backyards leading to the release of toxic substances through leaching or fumes (Babayemi et al., 2019). In recent years the capacity for plastic recycling in Africa has however increased and the exports of plastic waste leaving Africa have decreased (Holland, 2021). As the demand for recycled plastic is increasing, especially in Europe, the financial incentive for many countries to establish this infrastructure is also increasing.

Clean-up of contaminated sites and environmentally sound management of stockpiles

101. The production of UV-328 can also lead to emissions of the substance, which has been proven by the findings in the areas close to legacy production sites (ECCC and Health Canada, 2016; Jungclaus et al., 1978; Lopez-Avila & Hites, 1980). In addition, leachate from landfills containing UV-328 released to soil and water can generate sites contaminated with UV-328. Such contaminated sites should be identified and cleaned up by means of appropriate decontamination techniques. Information on methods currently used for the remediation of sites contaminated with POPs, including guidance on site assessment, remediation programs and risk assessment, is available from a variety of sources indicated in the corresponding Basel Convention technical guideline[16].

[16] Available at

102. If UV-328 is listed in Annex A, the Parties shall develop appropriate strategies to identify existing stockpiles and then ensure their environmentally sound disposal. This can efficiently contribute to avoid releases from such stockpiles.

Control of discharges or emissions

103. By listing UV-328 in Annex A and prohibiting the emissions from the production would cease and no further measures would need to be taken. If, however, continuous production is allowed, emission reduction measures should be applied, which should be based on BAT/BEP. The substance can be emitted via air and though the waste-water leaving the production facility, which is either treated on-site or in an external WWTP. It has already been mentioned that in WWTPs UV-328 mainly partitions to the solid phase and only a small share can be detected in the effluent (Brorström-Lundén et al., 2011; Montesdeoca-Esponda et al., 2021). In order to reduce emissions, measures should be put in place to reduce the concentration of UV-328 in waste-water and measurements should continuously be performed for monitoring purposes.

Clean-up of plastic debris from marine and other environments

104. As stated in the Risk Profile, the presence of UV-328 in marine plastic debris has been demonstrated in various studies (Karlsson et al., 2021; Rani et al., 2017; Tanaka et al., 2020). Such litter is ingested by seabirds or fish further spreading the substance. Several existing projects are trying to remove plastic debris from the world's oceans. However, plastic is continuously entering the oceans via rivers and the illegal dumping of waste. As such, the ban of the use of UV-328 is seen as the more effective tool in stopping its release to the environment. A more efficient approach would be preventative solutions to stop the release of plastic litter into marine environments (Karlsson, 2019). Nevertheless, the clean-up of plastic debris from marine and other environments can contribute to the removal of UV-328 from the environment.

Establishment of exposure limits in the workplace

105. According to information provided in U.S. EPA's ChemView database, 3 out of 5 companies/company sites for which data is available indicate that the number of industrial workers likely exposed during industrial processing and use of UV-328 is "not known or reasonably ascertainable". Other companies/company sites indicate that between "fewer than 10 workers" and "at least 10 but fewer than 25 workers" are likely exposed (US EPA, 2018). Further data on workplace exposure could not be identified. Based on the evaluation outlined in the risk profile (UNEP/POPS/POPRC.17/13/Add.3), where the exposure to UV-328 in the workplace is not seen as relevant, the establishment of exposure limits in the workplace is not considered an effective measure as regards to the aims of the Stockholm Convention.

Establishment of thresholds or maximum residue limits in water, soil, sediment or food

106. According to the Annex F submission of the Republic of Korea, UV-filters are found widely in marine organisms, however, health risks to humans posed by UV-filters in seafood cannot be determined as no acceptable daily intakes or benchmark concentrations are available (Annex F Republic of Korea, 2022). Due to the paucity of toxicity information available for UV-328, establishing thresholds or maximum residue limits for UV-328 in food is highly uncertain.

107. Releases of UV-328 from several sources lead to its occurrence in sewage sludge of WWTPs. The repeated application of sewage sludge to agricultural land may lead to increased concentration levels in the soil where the sludge is applied (there is no specific information available). The establishment of maximum residue limits for soil could help control soil levels and avoid risks arising from contaminated soil.

2.3 Information on alternatives (products and processes)

108. If listed in Annex A, the replacement of UV-328 by other chemicals or non-chemical alternatives would be needed. Based on the POPRC guidance on alternatives and substitutes, alternatives should be available, accessible, efficient as well as technically feasible. Moreover, the adoption of alternative substances or processes should ideally not substantially increase costs. This includes manufacturing costs as well as environmental and health costs related to the adoption of alternative substances or processes. Safer alternatives should be pursued, i.e. alternatives that either reduce the potential for harm to human health or the environment or that have not been shown to meet the Annex D screening criteria for listing a chemical under the Convention as a persistent organic pollutant (UNEP/POPS/POPRC.5/10/Add.1).

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http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines/tabid/8025/

2.3.1 General description of alternatives

109. **Phenolic benzotriazoles** are technically the most important UV absorbers (ECHA, 2020). In the automotive industry, they have been extensively used as light stabilizers in plastic and coating applications (Annex F ACEA, 2022). UV-328 can be substituted with other benzotriazoles (1-to-1 substitution) given that the necessary research efforts for the application-specific substitution of UV-328 are carried out (Annex F ACEA, 2022).
When UV-328 is replaced with other phenolic benzotriazoles, it should be noted that other substances of this chemical class also reveal hazardous properties and were added to the REACH Authorisation List (ECHA, 2020). This includes UV-320, UV-327 and UV-350 (Annex F UK, 2022; Khare et al., 2022). However, there are also non-SVHC listed phenolic benzotriazoles which can be used as substitutes (ECHA, 2020). An overview of other non-SVHC listed phenolic benzotriazoles which are used for the same applications as UV-328 and therefore could be used as substitutes is provided in Table 5 below (Germany, 2014). Unless indicated otherwise, the information on the availability and potential remarks were derived from ECHA (2022a).

Table 5: Overview of non-SVHC listed phenolic benzotriazoles. Source: (Annex F UK, 2022; ECHA, 2022a; Germany, 2014)**.**

Non-SVHC-listed benzotriazoles	Availability	Remark
UV-P (2-(2*H*-benzotriazol-2-yl-*p*-cresol); CAS No. 2240-22-4	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the European Economic Area (EEA), at ≥ 1,000 to < 10,000 t/a.	Under assessment to be classified as PBT.
UV-234 (2-(2*H*-Benzotriazol-2-yl)-4,6-bis(1-methyl-1-phenylethyl)phenol); CAS No. 70321-867	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the EEA, at ≥ 1,000 to < 10,000 t/a.	Under assessment to be classified as PBT.
UV-326 (2-*tert*-butyl-6-(5-chloro-2*H*-benzotriazol-2-yl)-4-methylphenol); CAS No. 3896-11-5	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the EEA, at ≥ 1,000 to < 10,000 t/a.	Under assessment to be classified as PBT.
UV-329 (2-(2*H*-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol); CAS No. 3147-75-9	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the EEA, at ≥ 1,000 to < 10,000 t/a.	Under assessment to be classified as PBT.
UV-360 (2-2'-Methylenebis[6-(2*H*-benzotriazol-yl)-4-(1,1,3,3-tetrametyhlbutyl)phenol]); CAS No. 103597-45-1	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the EEA, at ≥ 100 t/a.	According to the harmonized classification and labelling approved by the EU, this substance may cause long lasting harmful effects to aquatic life (H413).
UV-571 (2-(2*H*-benzotriazol-2-yl)-6-dodecyl-4-methylphenol); CAS No. 125304-04-3	This substance is not registered under the EU REACH regulation; however, internet searches have identified international suppliers. It is unclear if the substance is widely available (Annex F UK, 2022).	According to the classification provided by companies to ECHA in CLP notifications this substance is toxic to aquatic life with long lasting effects.
UV-928 (2-(2*H*-Benzotriazol-2-yl)-6-(1-methyl-1-phenylethyl)-4-(1,1,3,3-tetramethylbutyl)phenol); CAS No. 73936-91-1	This substance is registered under the REACH Regulation and is manufactured in and/or imported to the EEA, at ≥ 1,000 to < 10,000 t/a.	Under assessment to be classified as PBT.

110. As Table 5 shows, most of the phenolic benzotriazoles are manufactured in and/or imported to the European Economic Area (EEA) in volumes between 1,000 and 10,000 t/a (ECHA, 2022a). This suggests that they are widely available (Annex F UK, 2022). The chemical structures of the alternative phenolic benzotriazoles, with the exception of UV-360, are similar to UV-328. Most of the alternatives outlined in Table 5 are under assessment in the EU to be classified as PBT and their use is therefore possibly related to specific risks for health and/or the environment. Hence, replacing UV-328 with these alternatives may be a regrettable substitution. Safer alternatives should be pursued. Wang et al. (2022) investigated the occurrence and distribution of benzotriazole UV stabilizers (BUVs) in marine environments (sediment and seawater) in the Republic of Korea and found that several BUVs including UV-320, UV-P, UV-329 and UV-234 bioaccumulate or biomagnify (UV-327 and UV-928). According to Botkinchemie (2018) none of the alternatives (UV-P, UV-234, UV-326, UV-329 UV-360 and UV-928) meets the REACH criteria for identification as PBT or vPvB based on the available data. The data used to conclude that these substances don't meet

the criteria for classification as PBT has not been assessed[17]. Botkinchemie (2018) carried out a hazard assessment and concludes that the most attractive alternatives are UV-326, UV-329 UV-360 and UV-928. As outlined in Table 5, three of these substances are already under assessment to be classified as PBT.

111. **Benzophenones** represent another class of UV absorbers, which can be used as potential substitutes for UV-328 (ECHA, 2020). Benzophenones are used as additives in plastics, coatings and adhesive formulations (IARC, 2013). In addition, they are important as UV stabilizers for transparent plastics such as plastic packaging (ECHA, 2020; IARC, 2013). Benzophenones are mainly used for polyolefins and PVC applications (Grob et al., 2016). Further applications include the use as UV curing agent, flavor ingredient, fragrance enhancer and perfume fixative formulations (IARC, 2013). In 2009, the global consumption of benzophenones in thermoplastics was 4,900 t (Grob et al., 2016) suggesting that the substance is widely available. However, certain benzophenones are suspected to be endocrine disruptors (Carstensen et al., 2022; Germany Annex XV Dossier, 2014; Watanabe et al., 2015; Zheng et al., 2020) and hence, there is a risk for regrettable substitution. Other phenolic benzotriazoles may be more suitable alternatives (Annex F UK, 2022).

112. Further substances which can be used for the substitution of UV-328 and the protection of plastics from UV radiation include **HALS** (ECHA, 2020). In contrast to UV-328, these substances do not represent UV absorbers but function as proton donators, thereby inhibiting degradation (ECHA, 2020). HALS cannot technically replace a UV absorber. They protect against the radical attack on the surface of a substrate, while a UV absorber works according to Lambert–Beer Law in the depth of an article. They protect also against a different kind of deterioration of an article: a UVA protects against discoloration and loss of adhesion, while a HALS protect against chalking and blistering of a surface of an article[18]. HALS are often used in combination with other antioxidants or UV absorbers (Gou et al., 2014). In 2009, the volume of HALS compounds accounted for the largest share of the global consumption of light stabilizers in thermoplastics (46 % or 11,500 t) (Grob et al., 2016) indicating wide availability. HALS can be used for numerous polymers including PP (molding and fibers), PU as well as PVC and PS (when combined with UV absorbers) (Greenchemicals S.r.l., 2022; Todesco & Ergenc, 2002). HALS can also be used in thin section applications such as construction and industrial films, agricultural film or for packaging purposes (Todesco & Ergenc, 2002). Further applications include roofing membranes, exterior packaging and machine parts (Interspersal, 2022). Some HALS are related to specific adverse effects[19] and hence, there is a risk for regrettable substitution. Safer alternatives should therefore be selected carefully.

113. Other alternatives may be **oxalanilides** (Schaller et al., 2008). One example for an UV absorber of the oxalanilide class is UV-312 (Annex F UK, 2022). Its use is particularly recommended for rigid and flexible PVC but also for polyolefins (Greenchemicals S.r.l., 2022). UV-312 is registered under the REACH Regulation and is manufactured in and/or imported to the EEA at quantities higher than 10 t/a suggesting that the substance is widely available. As regards potential risks, no hazards have been identified for UV-312 (ECHA, 2022a). Oxalanilides represent an early class of UV absorbers and have been replaced in several applications by various benzotriazoles (Annex F IPEN and ACAT, 2022; Schaller et al., 2008).

114. **Cyanoacrylates** represent another potential alternative UV absorber (Annex F UK, 2022; Germany, 2015). One example is UV-3035 which can be used as light stabilizer in various polymers including amongst others PVC and PS. Most commonly, it is used in the electronics and building industry (MPI Chemie BV, 2022). UV-3035 is manufactured in and/or imported to the EEA in quantities between 100 and 1,000 t/a suggesting that the substance is widely available (ECHA, 2022a), however the substance is known to be irritating to the eyes and skin, cause damage to the organ and it is toxic to aquatic life (ECHA, 2022e).

115. Depending on substrate and durability requirements of the final plastic application, alternative chemistries indicated here are available to stabilize plastics, also within the benzotriazole class. Each UV absorber has its specific substance properties like its individual UV absorbance spectrum and its inherent physicochemical properties. HALS cannot simply replace a UV absorber and also benzophenones and oxalanilides do not have the same performance properties as UV-328. Therefore, the selection of a replacement candidate must be carefully evaluated in order to

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[17] Comment UK on 1st draft risk management evaluation

[18] Comment ELiSANA on 1st draft risk management evaluation referring to Hans Zweifel et al., Plastic Additives Handbook, 6th edition, ISBN 978-3-446-40801-2, Chapter 2.

[19] For example, Tinuvin 123 may cause long lasting harmful effects to aquatic life (ECHA, 2022d) and Tinuvin 292 is very toxic to aquatic life with long lasting effects, is very toxic to aquatic life and may cause an allergic skin reaction (ECHA, 2022c).

avoid reduction of the specified product performance.[20] For the identification of safer and appropriate alternatives for individual applications, information available e.g. in Grob et al. (2016) can be consulted. Information on the status of alternatives' regulatory assessments are available on relevant websites of authorities or other institutions.

2.3.2 Description of alternatives per (main) application

2.3.2.1 Use in plastics

116. The use of UV-328 in plastics and rubber (e.g., automotive industry, outdoor furniture, construction materials and food packaging) is estimated to be one of its main uses. According to ECHA (2020), phenolic benzotriazoles are technically the most important UV absorbers, in particular for transparent plastics. UV-328 is used as a light stabilizer in various polymers including acrylonitrile butadiene styrene resin, epoxy resin, fiber resin, propylene and polyvinyl chloride as well as unsaturated polyester, polyacrylate and polycarbonate (ECHA, 2020). Besides other phenolic benzotriazoles, also benzophenones, HALS, oxalanilides and cyanoacrylates may be used to substitute UV-328.

117. Based on regulatory, industrial and scientific data sources, Wiesinger et al. (2021) systematically investigated plastic additives on the global market. In total, the authors identified 762 light stabilizers (Wiesinger et al., 2021). According to the Annex F submission of IPEN and ACAT (2022), many of these light stabilizers are used in applications where UV-328 is used (Schaller et al., 2008; Wiesinger et al., 2021). The report of Wiesinger et al. (2021) demonstrates that particular attention should be paid to the potential harms of alternative light stabilizers to human health and/or the environment when substituting UV-328. To avoid regrettable substitution, these potential harms need to be taken into account (Annex F IPEN and ACAT, 2022; Wiesinger et al., 2021). According to IPEN and ACAT (2022), out of the 762 light stabilizers used in plastics, 47% were identified as substance of potential concern, 32% as being of high concern, 23% as carcinogenic, mutagenic or reprotoxic, 26% to cause specific target organ repeated toxicity and 30% to cause chronic aquatic toxicity (Annex F IPEN and ACAT, 2022). On the other 53% out of the 762 substances may particularly be considered as possible safer alternatives to UV-328. Information on over 400 substances used in the EU as additives in plastics is now available on ECHA's website. The listing is based on the technical functions of additives and data provided by industry on substances manufactured or imported at above 100 t/a. It covers substances used as UV/light stabilizers. Information on the polymer types that the additives are most commonly found in and the expected concentration ranges is also provided.[21]

2.3.2.2 Use in paints and coatings

118. The use as light stabilizer in paints and coatings is assumed to be another major application of UV-328 (see paragraph 59).

119. UV absorbers based on the benzotriazole chemistry are highly relevant for the paint industry (Schaller et al., 2008). In the case of UV-328, other benzotriazoles can be used as alternatives. One example is CAS No. 104810-48-2 that seems to have two acronyms (UV-1130 and UV-1300). Originally, UV-328 was used in aviation for maintenance purposes in the clearcoat "Aerodur Clearcoat UVR"[22], amongst others in Switzerland. However, the formulation has been changed and UV-328 was substituted by UV-1300 (AkzoNobel, 2020). UV-1300 can be applied in water and solvent based coatings including industrial metal coatings applications, plastic component coating applications, wood coatings and automotive coatings (BASF, 2015). UV-1300 as an individual substance is pre-registered under the REACH Regulation (ECHA, 2022a). It is, however, used in a mixture in a dimeric form under the same CAS No. (104810-48-2) which is registered under REACH with an annual amount of ≥100 t (ECHA, 2022f).

120. UV-1300 is a class of UV absorber with a free hydroxyl group, which can react with isocyanates and melamine matrices to form a covalent bond (BASF, 2015; Schaller et al., 2008). This prevents or at least reduces the migration and subsequent leaching of the adsorber and can reduce exposure to the substance. Therefore, it can be concluded that, when assessing alternatives such substances can be preferably used where applicable in order to prevent a regrettable substitution.

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[20] Comment ELiSANA on 1st draft risk management evaluation referring to Hans Zweifel et al., Plastic Additives Handbook, 6th edition, ISBN 978-3-446-40801-2, Chapter 2.

[21] See https://echa.europa.eu/-/high-volume-plastic-additives-mapped

[22] See for instance former Safety Data Sheets (SDS) of France (2017), USA (2018) or data available from the Irish Environmental Protection Agency's website (2005).

121. Another alternative is UV-400, a liquid hydroxyphenyl-triazine (HPT) UV absorber (Annex F UK, 2022; Hunan Chemical BV, 2022). The substance is recommended to be used for solvent and waterborne and 100% solids automotive and industrial finishes (Hunan Chemical BV, 2022). Its protection effects can be enhanced when used in combination with HALS (Hunan Chemical BV, 2022). According to ECHA (2022a), the substance is currently on the list of pre-registered substances. Further information on the availability could not be identified. According to Schaller et al. (2008), UV absorbers based on HPT have several advantages compared to benzotriazoles such as better photoperformance, heat stability and excellent chemical resistance and reveal better performance in application areas such as automotive as well as wood and powder clear coatings.

122. Companies are currently engaged in replacing UV-328. For example, one company has reported that it is working with customers to replace UV-328 (Interspersal Inc., 2020). Their efforts focused on eliminating SVHC-containing UV stabilizers by developing a single liquid blend for use in an aromatic urethane for replacing a typical customer blend of UV-328 and HALS (and potentially antioxidants) (Interspersal Inc., 2020). For this purpose, they tested 25 formulations (not containing SVHC substances) and identified 5 formulations which met or exceeded expectations concerning weathering performance in Quantitative Ultraviolet testing[23] (Interspersal Inc., 2020).

123. Concerning costs, feedback from a coatings and adhesives producer in the UK claims that substitution of UV-328 will result in transition costs including the evaluation of alternatives and the safe management of UV-328 stockpiles. The costs have not been quantified (Annex F UK, 2022).

124. Information provided in the Annex F submission of Japan (2022) indicates that the selection of alternatives is time-consuming for some uses due to the color changes of products (yellowing) and the decrease of weather fastness which may occur in the case of coating materials.

2.3.2.3 Other applications

125. Besides the information provided in chapter 2.3.1, no specific information could be identified concerning the substitution of UV-328 in application areas such as adhesives and sealants, textiles or construction materials. According to the Annex F submission of IPEN and ACAT (2022), several sources indicate the use of UV-328 in personal care products, which may include sunscreens. Alternatives to sunscreen are avoiding exposure to direct sunlight during periods of the day where UV-radiation is most harmful and wearing adequate clothing (Annex F IPEN and ACAT, 2022; Koch et al., 2017). Sunblock which protects from UV radiation through a physical barrier may be safer alternatives than sunscreens using different types of light stabilizers (Annex F IPEN and ACAT, 2022).

126. According to the Association of the Adhesives Industry in Switzerland, their members that participated in the survey are not intentionally adding UV-328 to adhesive formulations, neither as a raw material nor as an additive. This indicates that effective alternatives to UV-328 for adhesives are available. One company indicated that it is in the progress of replacing UV-328 by UV-928. Based on desktop research, several other examples of UV absorbers and HALS which can be used in adhesives and sealants can be identified. This includes for instance UV-1300, GC UV-80, GC UV LS 622 (CAS No. 65447-77-0), GC UV LS 765 (CAS No. 1065336-91-5), GC THANOX 565 (CAS No. 991-84-4) and GC THANOX 1330 (CAS No. 1709-70-2) (Greenchemicals S.r.l., 2022).

2.3.3 Evaluation of alternatives and summary

127. As indicated in the chapters 2.3.1 and 2.3.2 above, there are several alternatives to UV-328. The production and/or import quantities suggest that many of the alternative substances are widely available. Initial industry feedback suggests that the alternative substances represent suitable substitutes (Annex F UK, 2022) which are already supplied by registrants in the EU (ECHA, 2020). Furthermore, a registrant for UV-328 indicated that they will stop placing UV-328 on the market after the sunset date (27 November 2023) and do not plan to support any applications for authorizations. Moreover, co-registrants for the substance are confident that downstream users will switch to plastics containing the alternative substances (ECHA, 2020).

128. Specific information on the costs of the alternatives is only available to a limited extent. According to the Annex F submission of the UK (2022), there is a lack of information on the substitution costs, making a direct cost comparison difficult. For the UK, the Society of Motor Manufacturers and Traders (SMMT) indicated that the costs for substituting UV-328 in the automotive industry could not be provided due to competition rules (Annex F UK, 2022). Information submitted by Japan indicates that the substitution of UV-328 could result in increasing product prices due to the high costs of alternatives (Annex F Japan, 2022). Accordingly, the costs for evaluating alternatives may be significant in specific industries. This could, e.g., concern construction and automotive materials as well as

[23] QUV accelerated weathering testing is a laboratory simulation of the degrading effects of weather to predict the relative durability of materials exposed to outdoor conditions (Çakicier et al., 2011).

agricultural films due to the increased time requirements for exposure testing and the associated labor costs (Annex F Japan, 2022), however, alternatives with a higher initial purchase cost may actually be cheaper over the lifetime of the product (Ackerman & Massey, 2003). Additionally, the mass production of alternatives can lower their costs and oftentimes the cost of initiatives to protect health and the environment are frequently overestimated in advance and later decline rapidly after the regulation is implemented (Ackerman & Massey, 2003). The feedback suggests that for enabling efficient substitution of UV-328, possible control measures should enter into force at a reasonable timeframe which allows sufficient time for efficient and non-regrettable substitution. On the other hand, information provided, e.g., by ECHA (2020) and Wiesinger et al. (2021) suggests that several viable and economically feasible alternatives to UV-328 are available.

129. Detailed information regarding the efficacy of alternatives is lacking in some cases. Alternatives for the use of UV-328 in agricultural films may reveal functional issues concerning the transparent wavelength of sunlight and the weather fastness of the films (Annex F Japan, 2022). Furthermore, the selection of alternatives can be time-consuming due to the color change of products (yellowing) and the use of alternatives for displays, lenses and frames of eyeglasses may result in a decreasing optical and processing performance (Annex F Japan, 2022). According to Schaller et al., (2008) benzophenones and oxalanilides may reveal a reduced spectral coverage and inferior photoperformance compared to benzotriazoles. Apart from that, no further information on the efficacy of alternatives is available. Several technically as well as economically feasible alternatives seem to be available (ECHA, 2020). Besides the concerns brought forward by Japan, there is no information that, for a specific application, efficient alternatives are not available.

130. As outlined in the Annex F submission of Japan (2022), difficulties exist concerning the substitution of UV-328 in spare parts of automobiles including motorcycles, agricultural vehicles and construction machinery as well as in industrial vehicles, medical equipment, electric and electronic instruments and housing equipment. Difficulties include the production of samples for performance tests (Annex F Japan, 2022) and the technical challenges of testing alternatives (Annex F UK, 2022). The automotive industry has already started to investigate its uses of UV-328 and for many series applications, especially in the EU, the substitution of the substance is in progress (Annex F ACEA, 2022). According to the Annex F submission of ACEA (2022), the substitution process in vehicles is time-consuming and therefore a phase out of UV-328 could not enter into force before 2026 for vehicles which received their type approval before this date. Further, the substitution of UV-328 in LSPs will not be feasible particularly in spare parts for vehicles that are no longer in mass production or where spare parts production has ceased at all and spare parts have been put on stock.

131. It can be concluded that there are various alternatives available to substitute UV-328 as light stabilizer in plastics, paints and coatings as well as other applications such as adhesives and sealants. The alternatives include amongst others benzophenones, other benzotriazoles, HALS and oxalanilides as well as cyanoacrylates. However, data on costs and on specific applications of the alternatives and their efficacy is largely missing. For the most relevant applications alternatives seem to be technically feasible and accessible at sufficient quantities. This is supported by industry feedback which suggests that the alternative substances represent viable alternatives to UV-328 and that the placing of UV-328 on the market will discontinue in the EU after the sunset date (27 November 2023) (ECHA, 2020). Besides concerns indicated by Japan regarding alternatives in agricultural films as well as displays, lenses and eyeglasses, information is not available regarding the lack of viable alternatives for UV-328 in other specific applications. Concerns exist especially regarding the supply of LSPs in the automotive sector and the time-consuming substitution process. Hence, feedback from Parties and observers suggest that a corresponding specific exemption may be needed with a listing under the Convention, however the exemption should be kept as narrow and specific as possible to avoid unnecessary exposure. Substitutes to UV-328 should be selected and assessed carefully in order to avoid regrettable substitution. Safer alternatives should be pursued. This especially concerns the substitution with other benzotriazoles which are under assessment to be classified as PBT and could therefore be as harmful as UV-328 itself. However, this also applies to other potential alternatives such as benzophenones and other light stabilizers as described above.

2.4 Summary of information on impacts on society of implementing possible control measures

2.4.1 Health, including public, environmental and occupational health

132. UV-328 has been detected in various environmental media, including ambient air, water, soil, sediment, biota and humans. It is considered to be persistent and bioaccumulative, with significant adverse human health and/or environmental effects. Due to its long-range environmental transport, it has been detected in many regions over the world. POPRC-17 concluded that UV-328 is likely to lead to significant adverse human health and/or environmental effects as a result of its long-range environmental transport such that global action is warranted (UNEP/POPS/POPRC.17/13/Add.3).

133. Listing of UV-328 in Annex A, leading to a prohibition of production, use, import and export of UV-328 and environmentally sound management of stockpiles and waste, would have positive impacts on environment and health because releases to the environment and hence levels of UV-328 in the environment and biota including humans would decrease. If production, use, and waste management of UV-328 are not controlled, the levels in the environment including in humans and biota will likely continue to rise, even in locations far from production and use. The extent of the risks of UV-328 cannot be quantified, but global action is warranted. The risk management of UV-328 is driven by scientific data and precautionary action to avoid further adverse impacts resulting from continued emissions.

134. Within a short time period, a positive effect of imposing a global ban would be on the indoor environment as well as occupational and public health. UV-328 levels in dust would be reduced and ultimately eliminated by ending the use in indoor products such as plastic products, machine wash liquids, detergents and fragrances. Imposing a global ban would also ensure that levels of contaminated foodstuff such as fish or other seafood decrease over time. That would have positive effects on humans, especially on children who have shown to ingest more dust than adults. UV-328 has been found in human breast milk and adipose tissue (Kim et al., 2019; Lee et al., 2015; UNEP/POPS/POPRC.17/13/Add.3; Yanagimoto et al., 2011).

135. UV-328 is used in products used in the health care sector, according to the information provided by Japan and the EU, e.g., in medical equipment, medical, surgical or veterinary's instruments and apparatus (Annex F EU, 2022; Annex F Japan, 2022). There is, however, no specific information available in which medical products it is used. Banning the use of UV-328 could theoretically result in impacts on certain medical equipment and subsequently lead to unwanted impacts on health care.

136. For many of the uses of UV-328, chemical alternatives are widely available, depending on the use and industry, so that UV-328 could be replaced. However, specific alternative chemicals, such as some other phenolic benzotriazoles, also reveal hazardous properties. Three other phenolic benzotriazoles were added to the EU Authorisation List (ECHA, 2020) , while others are currently under assessment regarding their identification as SVHCs (see Table 5). In addition, substitutes to UV-328 should be selected and assessed carefully in order to avoid regrettable substitution. Safer alternatives should be pursued. UV-328 is a non-reactive plastic additive which can migrate and leach out of the plastic matrix and be released to the environment. There are reactive UV absorbers (e.g., with a free hydroxyl group which can react with melamine and isocyanate matrices to form a covalent bond) which do not migrate in the plastic matrix and are less prone to release from materials and to lead to human and or environmental exposure. Such chemical alternatives or chemicals with less hazardous properties or non-chemical alternatives can contribute to reducing adverse health impacts.

137. UV-328 occurs in recycled materials such as recycled plastics. The prohibition of reuse and recycling of wastes or stockpiles would result in further emission reductions of UV-328 and thus in positive impacts on public, environmental and occupational health.

138. These control measures and all other control measures discussed in section 2.2 aim at reducing releases of UV-328 to the environment and/or exposure to the substance. They all have the potential to reduce and/or minimize releases of and exposure of humans and the environment to UV-328. Hence, if the substance is replaced by safer alternatives, all the control measures would have positive impacts on health including public, environmental and occupational health.

139. Workers involved in the production of UV-328 and products or the treatment of waste containing UV-328 may be exposed to this chemical by inhalation or dermal uptake. By establishing occupational exposure limits below actual exposure levels in the workplace positive effects to the occupational health may be expected. However, if UV-328 is listed in Annex A to the Convention without exemptions, the exposure to workers is not seen as relevant and therefore the impact of exposure limits is not considered relevant. In case specific exemptions are made available, the establishment of appropriate exposure limits may be considered.

2.4.2 Agriculture, including aquaculture and forestry

140. UV-328 is expected to enter soil from the application of sewage sludge and as a result of the degradation of disposed products that contain UV-328. Degradation of agricultural films might be another source of emissions to soil. This is because UV-328 is not chemically bound to materials, and therefore processes such as abrasion, leaching and volatilization may result in the release of UV-328 from products into the environment. UV-328 has been found frequently in the influent, effluent and sludge from wastewater treatment plants (WWTPs) in many parts of the world (UNEP/POPS/POPRC.17/13/Add.3). Concentrations of UV-328 in crops are not known.

141. Applying sewage sludge to agricultural land is a way of managing sewage sludge while at the same time recovering essential plant nutrients and organic matter in agriculture. Applying UV-328 containing sewage sludge to agricultural soil contributes to the environmental releases of UV-328 into soil where it persists. Repeated application may lead to significant concentrations and adverse effects. Accordingly, measures to reduce the levels of UV-328 in

sewage sludge and/or measures to better control the use of sewage sludge as a fertilizer can contribute to avoid adverse effects due to high levels of UV-328 which might occur after repeated application of the UV-328 containing sewage sludge on agricultural land. It could, however, also lower the crop yield if the sewage sludge is not replaced by other suitable fertilizers. Pollutant free sewage sludge can be use as fertilizer in agriculture. Therefore, restricting the use of UV-328 could have benefits for agriculture.

142. UV-328 is used in agricultural film (Annex F Japan, 2022). As for the production of these films alternatives such as HALS are already available (Annex F Japan, 2022) no relevant impacts to agriculture are expected in this respect.

2.4.3 Biota (biodiversity)

143. While UV-328 has not been regularly included in monitoring campaigns, recent monitoring campaigns that did seek to measure UV-328 have found it in various environmental matrices and biota in source regions and in biota in remote regions, as well as in humans in many parts of the world. There is field-evidence that UV-328 enriches in top predators. UV-328 has been found to be associated with adverse health effects in mammals, in particular with toxic effects to liver and kidney. Although the levels of UV-328 in the environment are generally lower than adverse effect levels, potentials for adverse effects have been detected (UNEP/POPS/POPRC.17/13/Add.3).

144. Listing of UV-328 in Annex A to the Convention and replacing the chemical by safer alternatives would positively impact on biota by decreasing emissions during all life cycle phases and subsequently environmental levels and exposure of biota.

145. The clean-up of plastic debris from marine and other environments would also positively impact on biota by decreasing plastic debris and emissions of UV-328 into the oceans and biota. Significant amounts of plastics are released to the oceans every year and plastic debris is known to accumulate within each of the ocean gyres. These may act as sources of release of UV-328 to receiving environments (UNEP/POPS/POPRC.17/13/Add.3). Seabirds and other water dwelling animals may ingest the plastic debris, which has been proven for black foots albatross (Tanaka, van Franeker, et al., 2019) and other seabirds that feed in the open ocean (Tanaka, Yamashita, et al., 2019; Yamashita et al., 2021). A removal of marine plastics may therefore lower the exposure of UV-328 in marine animals. This would have the additional effect that less plastic would be ingested by biota and hence less adverse effects on biota from plastics in the environment would occur.

2.4.4 Economic aspects, including costs and benefits for producers and consumers and the distribution of costs and benefits

146. UV-328 is likely to lead to significant adverse human health and/or environmental effects such that global action is warranted. The economic aspects of banning the use of UV-328 and replacing it with safer alternatives include non-quantifiable savings made on health and environmental costs resulting from decreased exposure.

147. If a full ban of UV-328 comes into effect, alternatives would need to be used. In general, as indicated in chapter 2.3. there are many alternatives available for UV-328 and as such the transition costs are expected to be low. This is further indicated by the fact that the automotive industry is already in the process of replacing UV-328 in their products (Annex F UK, 2022). As a consequence, only low additional transition costs are expected. The costs will be especially low in countries which do not consume large amounts of UV-328. In general, the transition costs come from costs for reformulation and redevelopment of technologies for new alternatives as well as from the disposal of UV-328 containing wastes (Annex F UK, 2022).

148. When switching to alternatives, it is essential that regrettable substitution be avoided. This is especially important when looking at other benzotriazole UV-stabilizers. Switching to safer alternatives may require intensive testing by the producer and incur significant costs.

149. Besides the risk of regrettable substitutions as outlined in the paragraphs on the different alternative substances, further risks are associated with the substitution of UV-328. A phase out of UV-328 could lead to the LSPs containing UV-328 no longer being supplied on the market with no alternatives being available (Annex F UK, 2022). This can lead to a high economic burden on the SME that produce such parts as well as on the users of the vehicles, as they would be unable to maintain them (JAPIA, 2021). According to the Annex F submission of the UK (2022) this could further result in job losses and higher unemployment and corresponding social externalities. In addition, the supply of many products may be short in various industry sectors without sufficient time for substitution and large amounts of wastes may be generated if the stocks of LSPs and spare parts cannot be used any longer (Annex F Japan, 2022). However, in line with note (ii) of Annex A of the Convention, UV-328 occurring as constituents of LSPs manufactured or already in use before or on the date of entry into force of the relevant obligation, are not covered by the listing, provided that a Party has notified the Secretariat that a particular type of article remains in use within that Party.

150. A listing in Annex A to the Convention would also have impacts on the importers, vendors and down-stream users of UV-328. It was, however, stated by the suppliers of UV-328 in Europe that they will not prepare a REACH authorization dossier for the substance but rather switch to alternatives (ECHA, 2020). This indicates that the switch to alternatives can be performed without significant additional costs and within a reasonable time. Losses related to the phase out of UV-328 can be assumed to be balanced out by gains related to the increased use of alternatives.

151. If UV-328 is listed in Annex A or B to the Convention, wastes containing UV-328 must not be recycled. This would have an impact on the plastic waste treatment, as UV-328 containing articles will be present in specific plastic waste streams. As the amount of recycled plastic is increasing world-wide (Ritchie & Roser, 2018) the separation of contaminated fractions is becoming more and more important. However, no available techniques or suitable methods for the appropriate identification and separation of UV-328 in plastic waste could be identified and would need to be established. Furthermore, after identification the UV-328 containing parts would need to be separated from the fraction intended for recycling. The development and application of such technologies and techniques can be related to significant costs, will require significant time and might not be feasible for every country. According to the UK, if no technology for the separation of UV-328 containing plastics exists, high risk waste streams might have to be incinerated, which would be associated with high costs (Annex F UK, 2022), especially for countries with insufficient incineration capacities. The likelihood of identification and/or sorting of contaminated waste streams will be challenging and, if it's not known precisely which articles contain UV-328, will most likely result in increased incineration of plastics. This could be costly to implement and reduces the supply of recycled plastics[24].

152. Sewage sludge is used as land fertilizer in many countries (Buchauer, 2019), which may cause releases of UV-328. Avoiding the application of sewage sludge which contains UV-328 at or above the low POP content limit would be related to costs for the environmentally sound disposal of such sludge. On the other hand, not using such sludge as land fertilizer, would lead to non-quantifiable savings related to health and environmental costs. Many countries lack the required infrastructure for the environmentally sound management of sewage sludge. Sludge is often used as a cost-effective fertilizer. By prohibiting this use, the users would have to switch to other fertilizers which may be more expensive. Moreover, costs for the alternative management of sewage sludge would arise. On the other hand, since UV-328 is persistent in soil, if UV-328 will continuously be applied to soil this practice may lead to contaminated sites which would need to be remediated. The related cost may more than outweigh the costs for avoiding the application of sewage sludge to land.

153. The cost for the incineration of UV-328 containing waste can vary depending on the type of incinerator and country. The incineration of one tonne of general waste in the UK costs between \$65 and \$158[25]. One tonne of municipal non-hazardous waste costs \$186[25] and one tonne of specialist waste incinerated at temperatures above 1000 °C can cost up to \$621[25] per tonne. (Annex F UK, 2022). As UV-328 decomposes at temperature below 200 °C (ECHA, 2022b) general waste incinerators should be able to adequately destroy the substance. On the other hand, if UV-328 containing waste is not incinerated but landfilled, UV-328 may leach out of landfills and lead to contaminated sites which would need to be remediated. The related cost may more than outweigh the costs for appropriate incineration. Appropriate incineration would be related to non-quantifiable savings made on health and environmental costs resulting from decreased exposure. Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with UV-328 will be developed by an expert group jointly with the Basel Convention.

154. As stated earlier, the clean-up of marine plastic debris can help reduce the release of UV-328 in marine waters and biota. This clean-up is, however, costly and requires time. Additionally, the clean-up would have to be performed for a considerable time as plastic products in use containing UV-328 would continue to enter the world's oceans after the prohibition's entry into force. In Europe, the cost of cleaning one kilometer of coast can reach up to \$106,000[25] per year, however, this varies with local density population and cleaning frequency (Bergmann et al., 2015). Although the cost for the removal may be high, the effort to remove marine plastic litter is considered to be lower than the cost of inaction (Bergmann et al., 2015).

155. If the prohibition of the production of UV-328 comes into effect contaminated sites related to (legacy) production sites or landfills would have to be remediated to minimize the release of UV-328. The excavation and incineration of one ton of contaminated soil can cost \$1,500 (Jrank, 2022). On the other hand, if the contaminated sites is not managed in an environmentally sound manner, follow-up costs may be high. Further the remediation can

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[24] Comment UK on 1st draft risk management evaluation

[25] Amount was converted into US dollars. A conversion rate (£ to \$) of 1.3 was used based on: https://www.oanda.com/eu-en/ (accessed on April 7th, 2022).

be related to significant non-quantifiable savings made on health and environmental costs resulting from decreased exposure.

2.4.5 Movement towards sustainable development

156. Restricting UV-328 under Annex A to the Convention would support movement towards the United Nations Sustainable Development Goals (SDGs) established in 2015. Specifically SDG 12.4: responsible management of chemicals and waste, SDG 15.5 relating to action to halt biodiversity loss and SDG 3.9 to reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination would be supported by a ban of UV-328 (Annex F UK, 2022). Additionally, the ban would also align with the aim of the Strategic Approach to International Chemical management (SAICM). SAICM's Global Plan of Action contains specific measures to support risk reduction measures by advancing the use of safe and suitable alternatives to chemicals, including non-chemical alternatives to organic chemicals including POP (UNEP, 2012).

157. The aim of a circular economy is to maximize the reuse and recycling; however, hazardous substances should be separated from material cycles. This requires the identification and separation of waste streams of concern such as UV-328 containing waste streams. Until suitable identification and separation methods are available, high-risk waste streams might need to be incinerated leaving less material for recycling. However, if UV-328 containing waste can be efficiently identified and separated, the quantities of waste that require destruction will likely be comparatively low.

2.4.6 Social costs (employment, etc.)

158. In the EU, the authorization of UV-328 will probably lead to the phasing out of the substance as stakeholders have indicated that alternatives are readily available (ECHA, 2020). Also, other stakeholder have indicated that alternatives are available (Annex F IPEN and ACAT, 2022; Annex F Japan, 2022; Annex F UK, 2022) and as such a ban on UV-328 is not expected to cause significant effects on employment.

159. If, however the costs of the substitution are too significant or restrictive in some cases business may take measures to reduce the severity of such impacts such as cutting the number of personnel or even closing production sites. Such actions may lead to job losses and higher unemployment in the affected areas. This in turn can cause further social disruptions such as a higher crime rate, loss of human capital and skills and lower income tax revenue. Where the production is concentrated in certain regions, there may be an increased risk to cause regional disparities and impacts (Annex F UK, 2022). However, alternatives to UV-328 are widely available and relevant industries are already in the process of phasing out the substance. This indicates that such impacts are not considered very realistic. Negative impacts due to the phase out of UV-328 may be outweighed by positive impacts related to the use of safer alternatives.

160. Negative social impacts such as job losses or the close down of production facilities may be most severe if no exemption for the production of LSPs is made available. If LSPs containing UV-328 could not be supplied, this could have significant consequences for the SMEs that manufacture them. This could lead to a high number of job losses and resulting negative social impacts (Annex F ACEA, 2022; Annex F UK, 2022).

2.5 Other considerations

2.5.1 Access to information and public education

161. Parties and observers did not provide specific information regarding access to information and public education.

2.5.2 Status of control and monitoring capacity

162. Canada is currently investigating UV-328 in various environmental matrices and species in arctic biota as well as in water, air and fish of the Oils Sand region in Alberta. Moreover, relevant publications related to the analysis of UV-328 in water, suspended particulate matter, sediment, and fish from the St. Lawrence River, Quebec and in St. Lawrence Estuary beluga are under review or in preparation. Furthermore, other relevant projects related to UV adsorbents in deep sea redfish and surface waters and to plastic additives in liver, blubber and muscle samples from the Artic are underway (Annex F Canada, 2022)

163. In Korea a study was recently published monitoring the presence and trophic transfer of UV filters and stabilizers in the marine food web (Wang et al., 2022).

164. Together with other UV-substances, UV-328 is included in monitoring programs in Norway. This includes monitoring programs such as “Environmental pollutants in an urban fjord”[26], “Environmental pollutants in great lakes”[27] and "Environmental pollutants in the terrestrial and urban environment"[28] (Annex F Norway, 2022). Aggregated results of the various monitoring studies performed in Norway can be found online[29].

165. In the UK, UV-328 was added to the EA’s Gas Chromatography Mass Spectrometry (GCMS) target screen for water samples following the EA’s Prioritization and Early Warning System (PEWS) screening, in June 2021. However, as of January 2022, it has not been detected in the 54 analyzed sites across England, a majority of which are fresh water sites (Annex F UK, 2022).

3 Synthesis of information

3.1 Summary of risk profile information

166. Based on evidence of its persistence, bioaccumulation and toxicity in mammals, widespread occurrence in environmental compartments and frequent detection in biota in remote regions, it is concluded that UV-328 is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and/or environmental effects, such that global action is warranted.

167. UV-328 does not occur naturally in the environment. Yet, it has been found in various environmental matrices such as air, soil, sediment, water and biota as a result of anthropogenic activities. UV-328 has been found to be associated with adverse health effects based on findings from toxicity studies conducted in mammals and fish, and has been detected in humans in different regions of the world. It has been detected frequently in Arctic biota and in migratory seabirds on remote islands at levels that come close to adverse effect levels for their mammalian predators. Its frequent detection in remote regions is a result of its potential to undergo long-range environmental transport via air, water and migratory species.

168. UV-328 is persistent in soil and sediment where it can remain for many years. It has been found near legacy production sites, on beaches, in indoor dust, sludge and (waste-)water samples as well as in biota such as birds and fish in remote regions. In the food chain, bioaccumulation factors of above 5000 were estimated, which indicate the bioaccumulation potential of UV-328. This is further supported by the suggestion that the substance enriches in top predators such as finless porpoises.

169. Humans are exposed to UV-328 through the uptake of contaminated indoor dust and foodstuff such as fish and other seafood, leading to the detection of the substance in human breast milk and possible exposure of infants. In mammalian toxicity tests, the substance caused damage to the liver and kidney and there is limited evidence for adverse effects on male reproductive tract available.

3.2 Summary of risk management evaluation information

170. Restricting or prohibiting UV-328 would positively impact human health and the environment by decreasing emissions and subsequently human and environmental exposures.

Production, use and releases

171. UV-328 is a synthetic substance with no known natural occurrences. The substance is produced in Asia and the USA, however exact production amounts are unknown. The OECD designated the substance as a high production volume chemical with an annual production of > 1,000 tonnes.

172. In summary, UV-328 is used as a UV absorber. Based on the available information, the main uses are in plastics such as PP, PS, PVC, PU and rubbers used in the automotive industry, such as, automotive paints, coatings, sealants, adhesives, plastics and rubbers to protect materials from UV light-induced degradation or color-change, as well as various automotive fluids, such as, cooling and hydraulic liquids, and lubricants in motor oil. It can also be used as additives and printing inks in the plastics and rubbers for outdoor furniture, construction materials and food

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[26] https://www.miljodirektoratet.no/ansvarsomrader/overvaking-arealplanlegging/miljoovervaking/overvakingsprogrammer/basisovervaking/urban-fjord/

[27] https://www.miljodirektoratet.no/ansvarsomrader/overvaking-arealplanlegging/miljoovervaking/overvakingsprogrammer/basisovervaking/ferskvann/

[28] https://www.miljodirektoratet.no/publikasjoner/2019/september-2019/environmental-pollutants-in-the-terrestrial-and-urban-environment-2018/

[29] https://pub.norden.org/temanord2022-519/#97857

packaging in and wood products. Other uses also include applications in leather and textiles as well as cosmetics. Typical use concentrations range from 0.1% to 3% by weight.

173. Releases of UV-328 occur during all life cycle stages due to past and present production, manufacturing, transportation and final use of the substance as well as during the use, disposal and end-of-life treatment of products containing UV-328. Production and manufacturing sites of UV-328 are sources of releases. As UV-328 is not chemically bound to materials, the substance may be released from products and enter the environment, indicating the importance of the use and waste phase. Particular attention should be given to plastic litter containing UV-328 which might represent the main source of UV-328 in the marine environment and for biota ingesting plastics. Other sources of release include machine wash liquids, detergents, fragrances and air fresheners as well as textiles. In general, there is a lack of quantitative data on releases of UV-328. Sewage sludge may be another source of release of UV-328 to the environment.

174. While increased environmental concentrations have been found around legacy production sites, releases are also relevant in the use and the waste phase of the substance. A global ban on the production and use with an environmentally sound management of UV-328 containing waste are efficient to achieve an exposure reduction of humans and in the environment.

Summary of efficacy, efficiency and availability of appropriate alternatives

175. The European automotive industry represented by ACEA is currently in the process of phasing out UV-328. By 2026 the substance will be phased out from their new products. Therefore, ACEA concludes that a ban of UV-328 should not be effective prior to January 2026. However, also beyond this date, there would be challenges for LSPs containing UV-328 for use in legacy vehicles, defined as vehicles that have been type approved/certified prior to January 2026. According to ACEA, the substitution of UV-328 in LSPs will not be feasible, in particular for vehicles which are no longer in mass production or where the manufacturing of spare parts has ceased, and spare parts have been put on stock. A time-limited exemption for legacy spare parts could avoid unwanted impacts on manufacturers of spare parts and on the repairability of cars.

176. If UV-328 is listed to the Convention, wastes containing UV-328 at or above a low POP content value established in cooperation with the Basel Convention should be handled in such a way that the POPs content is destroyed or irreversibly transformed. To achieve this UV-328 containing products need to be identified and separated from recycled waste streams especially in mixed waste streams. The use of UV-328 in the automotive industry in paints and coatings as well in sealants and adhesives is not expected to significantly contribute to the presence of UV-328 in recycled products. During the waste management process these materials either flake of during shredding and are separated in the later process or are sent together with the metal to a metal recycling facility where the UV-328 is expected to be destroyed during the melting of the metal. On the other hand, the use of UV-328 in plastics in several sectors, including the automotive industry, may significantly contribute to the presence of UV-328 in recycled products. However, suitable detection and separation techniques could not be identified in literature and should be developed in the future. The technologies could be based on UV-spectroscopy or solvent based recycling in the case of plastics.

177. Due to the many uses of UV-328, it may be present in various waste streams, making its elimination difficult. A possible solution would be the creation of an inventory with common products and wastes containing UV-328, which could assist Parties in identifying relevant waste fractions and separable parts and could ultimately lead to a more efficient separation of the substance.

178. The environmentally sound disposal of UV-328 containing waste can be achieved through the destruction of UV-328. As UV-328 decomposes at temperatures below 200 °C, it can be assumed that the substance is destroyed in waste incineration facilities. As UV-328 does not contain halogen atoms, PCDDs/PCDFs or PBDDs/PBDFs or other halogenated POPs do not arise from its incineration. Additionally, UV-328 containing wastes can be landfilled, however, UV-328 may leach out of the waste and be emitted into the environment. As such, waste containing UV-328 over the low-POP content limit should only be disposed of in specially engineered landfills, designed to prevent leaching. Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with UV-328 will be developed by an expert group jointly with the Basel Convention.

179. When entering a WWTP, UV-328 sorbs to the solid phase and can mainly be found in the sewage sludge. In many countries the sludge is used as fertilizer in land applications which can lead to the direct application of UV-328 and other harmful substances on land. Sludge containing UV-328 should be disposed of in an environmentally sound manner.

180. As one of the main applications of UV-328 is in plastics, it can be found in marine litter through the release of plastic waste into the environment. There, it can be further spread via leaching and the ingestion of plastics by seabirds and other marine animals such as fish. A ban of the production and use of UV-328 can therefore help in preventing the further release of the substance to the environment. Additionally, plastic debris in the world’s oceans could also be cleaned-up to reduce the spread of the substance.

181. Alternatives for the substitution of UV-328 are widely available. Based on the information provided by parties and observers and the available information collected for the risk management evaluation, it can be concluded that alternatives for the most relevant applications of UV-328 seem to be technically feasible and accessible at sufficient quantities. This is supported by industry feedback which suggests that the alternative substances represent viable alternatives to UV-328 and that the placing of UV-328 on the market is expected to discontinue in the EU before 2024. Apart from concerns indicated by Japan regarding alternatives in agricultural films as well as displays, lenses and eyeglasses, there is no indication that for a specific application no viable alternatives would be available.

182. Several substitutes to UV-328 could be as harmful as UV-328. This applies in particular to the substitution with other phenolic benzotriazoles, which were added to the EU's Authorisation List or which are under assessment to be classified as PBT, but also to other potential alternatives such as benzophenones and other light stabilizers as described in chapter 2.3. Therefore, alternatives to UV-328 should be selected and assessed carefully in order to avoid regrettable substitution. Safer alternatives should be pursued.

Summary of information on impacts on society

183. Listing of UV-328 in Annex A, leading to a prohibition of production, use, import and export of UV-328 and environmentally sound management of stockpiles and waste, would have positive impacts on environment and health because releases to the environment and hence levels of UV-328 in the environment and biota including humans would decrease.

184. The effect of the global ban on health depends on the availability of safer alternatives. For many of the uses of UV-328, chemical alternatives are widely available, depending on the use and industry, so that UV-328 could be replaced. However, specific alternative chemicals, such as some other phenolic benzotriazoles, also reveal hazardous properties. Substitutes to UV-328 should be selected carefully in order to avoid regrettable substitution.

185. If UV-328 is listed in Annex A or B to the Convention, wastes containing UV-328 must not be recycled. However, no available techniques or suitable methods for the appropriate identification and separation of UV-328 in plastic waste could be identified and would need to be established. The development and application of identification and separation technologies could necessitate significant efforts.

186. Sewage sludge is used as land fertilizer which may cause releases of UV-328. Avoiding the application of sewage sludge containing UV-328 would be related to costs for the environmentally sound disposal of the sludge but would, on the other hand, lead to non-quantifiable savings made on health and environmental costs.

187. As UV-328 decomposes at temperatures below 200 °C general waste incinerators should be able to adequately destroy the substance. If UV-328 containing waste is not incinerated but landfilled, UV-328 may leach out of landfills and lead to contaminated sites which could need to be remediated at significant costs. Appropriate incineration would be related to non-quantifiable savings made on health and environmental costs resulting from decreased exposure. Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with UV-328 will be developed by an expert group jointly with the Basel Convention.

188. A removal of marine plastics can lower the exposure of UV-328 in marine animals. This has the additional effect that less plastic would be ingested by biota and hence less adverse effects on biota from plastics in the environment would occur.

189. A ban may also have impacts on the importers, vendors and down-stream users of UV-328. It was, however, stated by the suppliers of UV-328 in Europe that they will switch to other alternatives. Losses related to the phase out of UV-328 can be assumed to be balanced out by gains related to the increased use of alternatives.

3.3 Suggested risk management measures

190. The most efficient control measure for reducing the releases of UV-328 to the environment would be to list the substance in Annex A without exemptions. Listing UV-328 in Annex A would also entail that the provisions of Article 3 on export and import and of Article 6 on identification and sound disposal of stockpiles and waste would apply.

191. Based on the information submitted by parties and observers in the Annex F submissions during the risk management evaluation and the collective experience reported, the phase out of UV-328 may involve challenges for some sectors. Concerns exist especially regarding the supply of LSPs in the automotive sector and the time-consuming substitution process. Information provided by parties and observers indicates that the selection of alternatives for construction machinery and automotive materials as well as agricultural films requires time due to exposure testing. Thus, in order to enable an efficient substitution of UV-328 in the various applications, the ban should enter into force in a reasonable timeframe which allows sufficient time for efficient and non-regrettable substitution. An exemption for legacy spare parts could be made available to take into account the high economic burden on the SMEs manufacturing such parts and the risk of their unavailability, preventing maintenance of vehicles

concerned. However, the exemption should be time-limited, for example to a period of at least 15 years. This period is taken as an example from the US national obligations to deliver LSPs for this minimum duration after manufacture with original equipment parts (Fixing America's Surface Transportation (FAST) Act).

4 Concluding statement

192. Having decided that UV-328 is likely, as a result of long-range environmental transport, to lead to significant adverse effects on human health and/or the environment such that global action is warranted; and

193. Having prepared a risk management evaluation and considered the management options and noting that non-persistent organic pollutant alternatives to UV-328 are available;

194. The Persistent Organic Pollutants Review Committee recommends, in accordance with paragraph 9 of Article 8 of the Convention, the Conference of the Parties to the Stockholm Convention to consider listing and specifying the related control measures of UV-328 in Annex A with specific exemptions for the use in LSPs for motor vehicles and industrial machines.

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Please note: Information request submission and comments related to the risk management evaluation are available at the Stockholm Convention website at http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC17/POPRC17Followup/AnnexFUV328Submission/tabid/9100/

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