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Matters related to the implementation of the Convention: scientific and technical matters: technical guidelines

Technical guidelines

Addendum

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether, or tetrabromodiphenyl ether and pentabromodiphenyl ether, or decabromodiphenyl ether or Dechlorane Plus

Note by the Secretariat

1. As is mentioned in the note by the Secretariat on technical guidelines (UNEP/CHW.17/5), the annex to the present note sets out the draft updated technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether, or tetrabromodiphenyl ether and pentabromodiphenyl ether, or decabromodiphenyl ether or Dechlorane Plus which was prepared by the Secretariat, in consultation with the small intersessional working group on persistent organic pollutant wastes, for consideration by the Conference of the Parties.

2. The changes made to the technical guidelines adopted by the Conference of the Parties in its decision BC-14/4 during its fourteenth meeting in May 2019[1] have been tracked so that the revisions can be easily identified. The present note, including its annex, has not been formally edited.

* UNEP/CHW.17/1.

[1] UNEP/CHW.14/7/Add.3/Rev.1.

Annex

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether or tetrabromodiphenyl ether and pentabromodiphenyl ether or decabromodiphenyl ether or Dechlorane Plus (POP-BDEs and DP technical guidelines)

(Draft version of 18 December 2024)

Contents

Abbreviations and acronyms

ABS	acrylonitrile-butadiene-styrene
ATSDR	Agency for Toxic Substances and Disease Registry
BAT	best available techniques
BDE	brominated diphenyl ether
BDE-209	decabromodiphenyl ether congener 209
BEP	best environmental practices
BFR	brominated flame retardant
CAS	Chemical Abstracts Service
CENELEC	European Committee for Electrotechnical Standardization
c-decaBDE	commercial decabromodiphenyl ether
c-octaBDE	commercial octabromodiphenyl ether
c-pentaBDE	commercial pentabromodiphenyl ether
decaBDE	decabromodiphenyl ether (BDE-209) present in c-decaBDE
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DP	dechlorane Plus
EPDM	ethylene propylene diene monomer
ESM	environmentally sound management
EVA	ethylene-vinyl acetate
FI MoE	Ministry of the Environment of Finland
heptaBDE	heptabromodiphenyl ether
hexaBDE	hexabromodiphenyl ether
HIPS	high-impact polystyrene
ILO	International Labour Organization
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
nonaBDE	nonabrominated diphenyl ether
OECD	Organization for Economic Cooperation and Development
PA	polyamide
PBDEs	polybrominated diphenyl ethers
PBT	polybutylene terephthalate
PC	polycarbonate
PC-ABS	blend of PC and ABS
PCB	polychlorinated biphenyl
PDAP	polydiallylphthalate
PE	polyethylene
PEE	poly(ether ester)
PEE-HIPS	blend of PEE and HIPS
pentaBDE	pentabromodiphenyl ether
PET	polyethylene terephthalate
POP	persistent organic pollutant
POP-BDEs	hexabromodiphenyl ether and heptabromodiphenyl ether, tetrabromodiphenyl ether and pentabromodiphenyl ether, and decabromodiphenyl ether
PP	polyamide polymers/propylene
PUR	polyurethane
PS	polystyrol
PVC	polyvinyl chloride

SPE	solid phase extraction
tetraBDE	tetrabromodiphenyl ether
UNEP	United Nations Environment Programme
UPE	unsaturated polyester
USEPA	United States Environmental Protection Agency
WEEE	waste electrical and electronic equipment
WHO	World Health Organization

Units of measurement

mg/kg	milligram per kilogram (corresponds to parts per million by mass)

I. Introduction

A. Scope

1. This document supersedes the technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether or tetrabromodiphenyl ether and pentabromodiphenyl ether, of May ~~2015~~2019.

2. The present guidelines provide guidance on the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE), or tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE), or the decabromodiphenyl ether congener 209 (BDE-209), present in commercial decabromodiphenyl ether (decaBDE), or Dechlorane Plus (DP) pursuant to several decisions of multilateral environmental agreements on chemicals and wastes.[1]

3. HexaBDE and heptaBDE, as well as tetraBDE and pentaBDE, were listed in Annex A (Elimination) to the Stockholm Convention on Persistent Organic Pollutants in 2009, through an amendment that entered into force in 2010. BDE-209 present in commercial decaBDE was listed in Annex A to the Stockholm Convention in 2017 and the amendment entered into force in 2018. In the present guidelines, hexaBDE, heptaBDE, tetraBDE, pentaBDE and decaBDE, as a group, are referred to as persistent organic pollutant (POP) brominated diphenyl ethers (POP-BDEs). DP was listed in Annex A (Elimination) to the Stockholm Convention on Persistent Organic Pollutants in 2023, through an amendment that entered into force in 2025. For further specifications, see section II.B. of the present guidelines.

4. The present guidelines should be used in conjunction with the general technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (UNEP, ~~2019~~[2025]), hereinafter referred to as the general technical guidelines. The general technical guidelines are intended to serve as an umbrella guide for the ESM of wastes consisting of, containing or contaminated with POPs. It is also useful to consult Guidance on best available techniques and best environmental practices relevant to the polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention (UNEP, 2021: currently being updated to include also DP).

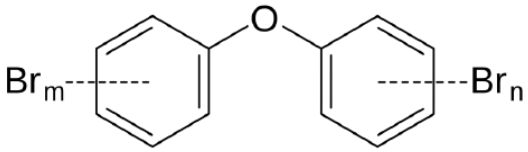
B. Description, production, use and wastes

1. Description

5. ~~Brominated flame~~ Flame retardants are chemical substances used to reduce fire hazards by interfering with the combustion of the polymer. Some ~~brominated~~ halogenated flame retardants, such as polybrominated diphenyl ethers (PBDEs) and DP, are additives that do not bind to plastics chemically, but are combined with them physically and, therefore, may be easily released into the environment.

6. PBDEs have different degrees of bromination ranging from one to ten bromine atoms. Figure 1 shows the structure of PBDEs.

Figure 1
Structure of PBDEs.



7. PBDEs are industrial aromatic organobromine chemicals that make up a group consisting of 209 congeners. The most common commercial formulations of PBDEs, as shown in table 1 of the

[1] Decisions BC-11/3, BC-12/3, BC-13/4 and BC-14/4 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; decisions OEWG-8/5, OEWG-9/3, and OEWG-11/3 of the Open-ended Working Group of the Basel Convention; and decisions SC-4/14, SC-4/18, SC-5/9, SC- 6/11 and SC-8/10 of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants.

present guidelines, are commercial octabromodiphenyl ether (c-octaBDE), commercial pentaBDE (c-pentaBDE) and commercial decaBDE (c-decaBDE).

8. C-octaBDE denotes a commercial mixture that typically contains mainly hexaBDEs, heptaBDEs, octaBDEs and nonabrominated diphenyl ethers (nonaBDEs). The phrase "hexaBDE and heptaBDE" covers, according to part III (Definitions) of Annex A to the Stockholm Convention, BDE-153, BDE-154, BDE-175, BDE-183 and other hexaBDEs- and heptaBDEs present in c-octaBDE.

9. C-pentaBDE denotes a commercial mixture that typically contains tetraBDEs, pentaBDEs and hexaBDEs. The phrase "tetraBDE and pentaBDE" covers, according to part III of Annex A to the Stockholm Convention, BDE-47, BDE-99 and other tetraBDEs and pentaBDEs present in c-pentaBDE.

10. C-decaBDE denotes a commercial mixture that typically contains mainly BDE-209, with low levels of other PBDE congeners such as nonaBDE and octaBDE (UNEP, ~~2015g~~2015e).

11. Components of c-pentaBDE, c-octaBDE and c-decaBDE mixtures are POPs according to Annex A to the Stockholm Convention. They have adverse effects on human health and the environment, are persistent, bioaccumulate and undergo long-range transport. C-decaBDE, with its main constituent decaBDE, also degrades to lower-brominated PBDEs, including hexaBDE, heptaBDE, tetraBDE and pentaBDE, with known persistent, bioaccumulative and toxic properties that contribute to decaBDE toxicity. Owing to debromination and to historical reservoirs of c-pentaBDE and c-octaBDE congeners in the environment, organisms are exposed to a complex mixture of PBDEs that, in combination, pose a greater risk than BDE-209 alone (UNEP, 2014).

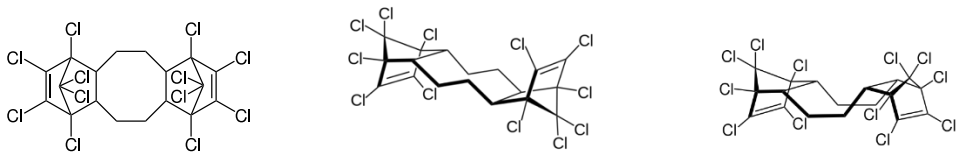
Table 1
Typical composition of PBDE commercial mixtures (Environment Canada, 2013)

Commercial mixtures	**PBDE congener groups and concentrations of active ingredient**						
	tetraBDE	**pentaBDE**	**hexaBDE**	**heptaBDE**	**octaBDE**	**nonaBDE**	**decaBDE**
	BDE-47, etc.	BDE-99, etc.	BDE-153, BDE-154, etc.	BDE-175, BDE-183, etc.	BDE-203, BDE-204, etc.	BDE-207, BDE-208	BDE-209
c-pentaBDE	24%–38%	50%–62%	4%–12%	trace	–	–	–
c-octaBDE	–	0.5%	12%	45%	33%	10%	0.7%
c-decaBDE	–	–	–	–	trace	0.3%–3%	97%–98%

12. The "Dechlorane Plus"™ (DP) technical mixture is a commercially available polychlorinated flame retardant, often marketed to replace c-decaBDE. The technical DP mixture is a white powder and contains two stereoisomers, *syn*-DP and *anti*-DP, that are present in ratios of about 1:3 or 25 % *syn*-DP and 75 % *anti*-DP. Commercially available DP mixtures may also contain DP monoadducts, mono-dechlorinated DP and other substances as impurities. Examples of trade names of commercial formulations that contain or have contained DP are provided in Annex I.

Figure 2
Structure of Dechlorane Plus, *anti*- Dechlorane Plus and *syn*- Dechlorane Plus.

Dechlorane Plus (CAS No. 13560-89-9)	*anti*- (or *exo*) Dechlorane Plus (CAS No. 135821-74-8)	*syn*- (or *endo*) Dechlorane Plus (CAS No. 135821-03-3)



2. Production

(a) C-octaBDE

~~12.~~13. Parties to the Stockholm Convention shall prohibit and/or eliminate the production of hexaBDE and heptaBDE. There are no exemptions under the Convention for production of the chemical. Information on the status of ratification by Parties of the amendment listing hexaBDE and heptaBDE in the Stockholm Convention can be found on the website of the Treaty Section of the United Nations (https://treaties.un.org/).

~~13.~~14. C-octaBDE has been produced in France, Israel, Japan, the Netherlands, the United Kingdom of Great Britain and Northern Ireland and the United States of America. Estimated annual worldwide production of c-octaBDE was 6,000 tonnes in 1994, which had decreased to 3,800 tonnes by 2001. Estimated total production of c-octaBDE between 1970 and 2005 was 102,700–118,500 tonnes (Schenker, 2008). No information is available on whether c-octaBDE is being produced in developing countries (~~Persistent Organic Pollutants Review Committee~~UNEP, 2008a).

(b) C-pentaBDE

~~14.~~15. Parties of the Stockholm Convention shall prohibit and/or eliminate the production of tetraBDE and pentaBDE. There are no exemptions under the Convention for the production of the chemical. Information on the status of ratification by Parties of the amendment listing tetraBDE and pentaBDE in the Stockholm Convention can be found on the website of the Treaty Section of the United Nations (https://treaties.un.org/).

~~15.~~16. C-pentaBDE used to be produced in the European Union, Israel, Japan and the United States, but production ceased in 2004 (UNEP, 2006a). According to the Norwegian Environment Agency (2015), it is possible that China also produced the chemical for its own market. It is assumed that, as of the late 1990s, c-pentaBDE was produced mainly in the United States. The estimated global production of c-pentaBDE from 1970 to 2005 was between 91,000 and 105,000 tonnes (Watson et al., 2010).

(c) C-decaBDE

~~16.~~17. Parties to the Stockholm Convention shall prohibit and/or eliminate the production of decaBDE, with specific exemptions for the production of c-decaBDE described in part I of Annex A to the Stockholm Convention as allowed for the Parties listed in the register of specific exemptions available on the website of that Convention (www.pops.int). Information on the status of ratification by Parties of the amendment listing decaBDE in Annex A to the Stockholm Convention can be found on the website of the Treaty Section of the United Nations (https://treaties.un.org/).

~~17.~~18. Available production data indicate that c-decaBDE has accounted for about 75 per cent of global production of PBDEs. Currently c-decaBDE is manufactured in only a few countries. Many countries have already restricted or launched voluntary programmes to phase out the production of c-decaBDE. Total production of c-decaBDE in the period from 1970 to 2005 was between 1.1 and 1.25 million tonnes. According to document UNEP (2014)~~/POPS/POPRC.10/3~~, the overall scale of current c-decaBDE production today is unknown, and data on production, trade and stockpiles is available for some countries only. Production of c-decaBDE is continues in a few countries, such as China and India. The annual production capacity of decaBDE in China in 2013, for example, was 49,000 tonnes (Zhang et al., 2017). Production of c-decaBDE no longer occurs in the European Union or in the United States.

(d) Dechlorane Plus (DP)

19. Parties to the Stockholm Convention shall prohibit and/or eliminate the production of DP in accordance with part I of Annex A to the Stockholm Convention. Information on the status of ratification by Parties of the amendment listing DP in Annex A to the Stockholm Convention can be found on the website of the Treaty Section of the United Nations (https://treaties.un.org/).

20. Available information on the volumes of DP produced, imported and exported is limited, but is low compared to POP-BDEs. DP was recently produced only in China, at estimated 300-1000 tonnes per year since 2003. China having issued the list of emerging pollutants under priority control (2023 Edition),~~ T~~the production, use, import and export of DP was banned since January 1st 2024.[2] Dechlorane Plus has also been produced in the USA since the 1960s in quantities between 450-5 000 tonnes per year, but recent information indicates that production has ceased (UNEP, 2022a).

3. Use[3]

(a) C-octaBDE

~~18.~~21. Parties to the Stockholm Convention shall prohibit and/or eliminate the use of hexaBDE and heptaBDE, unless they have notified the Secretariat of their intention to use either chemical for an acceptable purpose or in accordance with a specific exemption described in part IV

[2] Ministry of Ecology and Environment of China, 2023, the list of emerging pollutants under priority control (2023 Edition) https://www.mee.gov.cn/gzk/gz/202212/t20221230_1009192.shtml

[3] "Use" covers the use of POP-BDEs and DP as chemicals in the production of products and articles, as well as the use of those products and articles.

(Hexabromodiphenyl ether and heptabromodiphenyl ether) of Annex A to the Convention. HexaBDE and heptaBDE are still being used in accordance with the specific exemption therein that allows Parties to use, recycle or dispose of articles that contain or may contain hexaBDE and heptaBDE. Information on specific exemptions can be found in the register of specific exemptions on the website of that Convention (www.pops.int).

~~19.~~22. C-octaBDE is used mostly as an additive flame retardant in the manufacturing of plastic polymers, particularly in acrylonitrile-butadiene-styrene (ABS) polymers. ABS is used in casing of electrical and electronic equipment, such as office equipment, automotive parts and appliances, business machines, computers, business cabinets, pipes and fittings. A minor amount is also being produced for use as an additive in high-impact polystyrene, polybutylene terephthalate and polyamide polymers/propylene (~~Persistent Organic Pollutants Review Committee~~UNEP, 2008a). C-octaBDE has typically been added at concentrations between 12 and 18 per cent by weight (UNEP, 2007~~/POPS/POPRC.3/14~~). In 2003, the market demand for c-octaBDE was split, with around 40 per cent, each, being used in America and Asia, around 15 per cent in Europe and approximately 5 per cent in the rest of the world. Around 95 per cent of the c-octaBDE supplied in the European Union was used in ABS, with the global figure being approximately 70 per cent (Watson et al., 2010).

(b) C-pentaBDE

~~20.~~23. Parties to the Stockholm Convention shall prohibit and/or eliminate the use of tetraBDE and pentaBDE unless they have notified the Secretariat of their intention to use either chemical for an acceptable purpose or in accordance with a specific exemption described in part V (Tetrabromodiphenyl ether and pentabromodiphenyl ether) of Annex A to the Convention. TetraBDE and pentaBDE are still being used in accordance with that specific exemption, which allows Parties to use, recycle or dispose of articles that contain or may contain tetraBDE and pentaBDE. Information on specific exemptions can be found in the register of specific exemptions of the Stockholm Convention on the Convention website (www.pops.int).

~~21.~~24. Before C-pentaBDE was phased out in the United States in 2004, 97 per cent of global production of c-pentaBDE was used in that country and in Canada. Alcock et al. (2003) estimated that, in the period up to 2000, 85,000 tonnes of pentaBDE were used in the United States and 15,000 tonnes in Europe. PentaBDEs may have been used in Asia, but no reliable data are available to confirm this.

~~22.~~25. In some regions, c-pentaBDE was used almost exclusively as a flame retardant in the manufacture of flexible polyurethane (PUR) foams, with between 90 and 95 per cent of c-pentaBDE used for that purpose. This foam may contain between 10 and 18 per cent c-pentaBDE (UNEP, 2006a). Flexible PUR foams were used mainly in automotive and upholstery applications, electrical and electronic equipment, building materials, furniture, textiles and packaging. C-PentaBDE has also been incorporated in textiles, paints, lacquers, in rubber goods (conveyer belt, coating and floor panels) and in oil drilling fluids at levels ranging from 5-30% by weight (UNEP, 2006a).

(c) C-decaBDE

~~23.~~26. Parties to the Stockholm Convention shall prohibit and/or eliminate the use of decaBDE, unless they have notified the Secretariat of their intention to use it in accordance with a specific exemption described in parts I and IX (Decabromodiphenyl ether) of Annex A to the Stockholm Convention. Information on specific exemptions can be found in the register of specific exemptions on the website of that Convention (www.pops.int).

27. C-decaBDE consumption peaked in the early 2000s and it is still used worldwide (UNEP, ~~2017e~~2017d). C-decaBDE has a variety of applications including in plastics, textiles, adhesives, sealants, coatings and inks. C-decaBDE-containing plastics are used in electrical and electronic equipment, wires and cables, pipes, ~~and~~ carpets and some lead-acid batteries (WRc, 2023). In textiles, c-decaBDE is used mainly in upholstery, window blinds, curtains and mattresses for public and domestic buildings and in the transportation sector. The amount of c-decaBDE used in plastics and textiles globally varies, but up to about 90 per cent of c-decaBDE ends up in plastics, including plastics used in electrical and electronic equipment, while the remainder is used in coated textiles, upholstered furniture and mattresses (UNEP, ~~2015g~~2015e). Typically c-decaBDE is used in plastics/polymers at loadings of 10-15% by weight, though in some cases loadings as high as 20% have been reported. The amount applied in textiles was usually between 7.5-20% (UNEP, 2015e), C-decaBDE has also been used in modelling clay, washing and cleaning products and cosmetics and personal care products.[4]

[4] https://echa.europa.eu/substance-information/-/substanceinfo/100.013.277, accessed on 20 March 2018.

(d) DP

28. Parties to the Stockholm Convention shall prohibit and/or eliminate the use of DP, unless they have notified the Secretariat of their intention to use it in accordance with a specific exemption described in parts I and XI (Dechlorane Plus) of Annex A to the Stockholm Convention. Information on specific exemptions can be found in the register of specific exemptions on the website of that Convention (www.pops.int).

29. DP is primarily used as a flame-retardant in wire harnesses, connectors and insulation tape in motor vehicles, which account for the largest use volumes globally. Other significant uses are in adhesives, sealants and polymers. In addition, other confirmed FR uses for DP include in polymer production and plastic mouldings, and two-part resins for aerospace and defence applications. It is also used in electrical and electronic equipment (EEE), marine, garden and outdoor power equipment including forestry machinery, and medical and radiotherapy devices/ installations. DP is also used as a flame-retardant in construction, agricultural, and industrial machinery and in infrastructure applications and in smaller volumes as an extreme pressure additive in greases. DP has a minor use as a colour intensifier in explosives in fireworks (UNEP, 2022a). Detailed information on different applications of DP can be found in UNEP (2022b).

30. The typical application rates of DP in different types of plastics vary between 8% in polybutylene terephthalate and 40% in silicone rubber (UNEP, 2022b; Norwegian Environment Agency, 2021).

~~24.~~31. Around 80% (500 – 700 tonnes) of the total global use of DP in the automotive sector is reported to be in cables and wires (UNEP, 2022b).

4. Wastes

~~25.~~32. Wastes consisting of, containing or contaminated with POP-BDEs or DP (hereinafter referred to as POP-BDEs or DP wastes) may be found in:

(a) Solid, obsolete stockpiles of POP-BDEs or DP ~~and their related substances~~ in original packages that are no longer usable;

(b) Solid wastes from producers and users of POP-BDEs or DP;

(c) Wastewater from industrial and municipal processes and residues from wastewater cleaning such as activated carbon treatment;

(d) Products and articles (such as electrical and electronic equipment, building materials, plastics, textiles, adhesives, sealants, coatings, inks, wires and cables, pipes, carpets, upholstery, window blinds, curtains, mattresses, and vehicles, aircrafts, trains and ships)[5] including products containing recyclates made of plastics containing POP-BDEs[6] or DP[7] that have become waste;

(e) Municipal and industrial sludges, contaminated soil[8] and sediments;

(f) Waste incineration residues, in particular[9] from the incineration of waste containing POP-BDEs;

(g) Landfill leachate (Wang et al., 2016; Sibiya et al., 2019).

~~26.~~33. Action with regard to waste streams containing a high volume and concentration of POP-BDEs and DP will be essential for eliminating, reducing and controlling the environmental load created by POP-BDEs and DP. In that respect, the following should be recognized:

(a) It is likely that POP-BDEs or DP are released into the environment throughout their life cycles (production, product assembly, consumer use and disposal, including shredding[10] and recycling);

[5] C-decaBDE is used in all types of vehicles in the transport sector, including cars, aircraft, trains and ships (UNEP, 2015g).

[6] For example, toys, hairdressing accessories and aids and kitchen utensils, from black plastic in particular, and carpet paddings (see DiGangi et al., 2011; DiGangi and Strakova, 2016; DiGangi et al., 2017; Kuang et al. 2018).

[7] Norwegian Environment Agency, 2021.

[8] Soil may be of concern around e-waste sites and recycling plants and on account of the application of contaminated sludge (UNEP, 2015g: paragraphs 43, 109 and 110).

[9] Borgnes and Rikheim, 2005; Wang, Chen et al., 2010.

[10] Mechanical treatment such as shredding seems to be a relevant source of PBDE releases into the environment (FI MoE, 2016; German Federal Environment Agency, 2017).

(b) Waste-management activities have been identified as one route through which POP--BDEs or DP can enter the environment, mainly through industrial and municipal wastewater discharges to surface water and through leachate from landfills;

(c) Wastes may contain varying concentrations of ~~POP-BDEs~~flame-retardants, depending on the quantities in which POP-BDEs or DP were originally present in specific products and the quantities released during product use and waste management.

~~27.~~34. Waste streams of significance in terms of potential volume or concentration are:

(a) PUR foams used, for example, in applications in the transport sector and in upholstery, in the case of c-pentaBDE and DP;

(b) ABS polymers used for casings of electrical and electronic equipment, in the case of c-octaBDE and DP;

~~(b)~~ Wire harnesses, connectors, and insulation tape in motor vehicles, in the case of DP;

(c) Solid wastes (in particular plastics) from electrical and electronic equipment, vehicles, aircraft, trains and ships, construction and demolition, textiles and furniture;[11]

(d) Sludge and wastewater from municipal treatment plants, contaminated soil;

(e) Landfill leachate (Wang et al., 2016; Sibiya et al., 2019).

~~28.~~35. POP-BDEs or DP wastes can be generated in a diverse range of applications, at different stages of the life cycles of the ~~POP-BDE~~flame-retardants and through different environmental release media. Knowledge of release media guides the analysis and choice of methods that may be required to manage these wastes. Table 2 provides an overview of relevant information on the life cycles of POP-BDEs and DP wastes.

Table 2
Overview of the production and application of POP-BDEs and DP and the media for their release into the environment (sources: UNEP, ~~2015g~~2015e; UNEP, 2017de; decision SC-8-/10 of the eighth meeting of the Conference of the Parties to the Stockholm Convention; UNEP, 2022a; decision SC-11/10 of the eleventh meeting of the Conference of the Parties to the Stockholm Convention).

Group	Source materials /substances used	Applications	End products	Release media
PRODUCTION OF POP-BDEs				
Chemical production of PBDEs	Diphenyl oxide, bromine	Chemical synthesis	POP-BDE chemicals	Solid waste Water Sludge Air
Chemical production of DP	Hexachlorocyclopentadiene, cyclooctadiene	Chemical synthesis	DP commercial product	Solid waste Water Sludge Air
PRODUCTION OF ARTICLES CONTAINING POP-BDEs or DP				
Plastics	Raw materials (e.g., ethylene, propylene, vinyl acetate, acrylonitrile, butadiene, styrene, isocyanate, polyhydric alcohols, polystyrene, prolene, butanediol, terephthalate, ethylene glycol,	Expansion and moulding	Flame-retardant polymers: • polyolefins (PE, PP, EVA) • styrenics (PS, HIPS, ABS) • engineering thermoplastics (PET, PBT, PA (including nylon), PC, PC-ABS, PEE-HIPS~~, nylon~~) • thermosets (UPE, epoxies, melamine-based resins, PDAP) • elastomers (EPDM rubber, thermoplastic PUR, EVA)	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air

[11] UNEP, 2017de: chapter 3.3.

Group	Source materials /substances used	Applications	End products	Release media
	terephthalic acid, hexamethylenediamine and adipic acid) ~~POP-BDEs~~flame-retardants and other additives		• waterborne emulsions and coatings (acrylic-, PVC-, ethylene vinyl chloride- and urethane-emulsion)	
Building materials	PUR foam POP-BDEs and other additives DP Plastics made from flame-retardant polymers	Expansion and moulding	Board fireproofing: • Old-bridge insulation • Floors • Basement walls and foundations • Inverted roofs • Ceilings • Cavity insulation • Composite panels and laminates • Roofing materials, such as membranes and films • Epoxy adhesive • Electrical insulation • Commercial-grade carpeting	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Textile production	Flame-retardant textiles (back-coating of fabrics)		Residential and commercial upholstered furniture Transportation seating Wall coverings and draperies Protective clothing and other technical textiles Tents	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Electric and electronic equipment	Plastics made from flame-retardant polymers	Production of components for electronic and electric equipment	Electric and electronic appliances Electric insulation Analytical instruments Medical devices	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
~~Transport~~**Vehicles and industrial machines**	Plastics containing POP-BDEs or DP Flame-retardant fabric (made from flame-retardant polymers)	Manufacturing of vehicles, including cars, aircraft, trains and ships	Products used in manufacturing cars, aircraft, trains, ~~and~~ ships, and stationary industrial machines. Examples in relation to cars include: • Powertrain and under-hood applications, such as battery mass wires, battery interconnection wires, mobile-air-conditioning pipes, powertrains, exhaust manifold bushings, under-hood insulation, wiring and harness under hood (engine wiring, etc.), speed sensors, hoses, fan modules and knock sensors • Fuel-system applications such as fuel hoses, fuel	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air

Group	Source materials /substances used	Applications	End products	Release media
			tanks and fuel tanks under body • Pyrotechnical devices and applications affected by pyrotechnical devices, such as airbag ignition cables, seat covers/fabrics (only if airbag relevant) and airbags (front and side) • Suspension and interior applications, such as trim components, acoustic material and seat belts • Reinforced plastics (instrument panels and interior trim) • Under the hood or dash (terminal/fuse blocks, higher-amperage wires and cable jacketing (spark-plug wires)) • Electrical and electronic equipment (battery cases and battery trays, engine-control electrical connectors, components of radio disks, navigation satellite systems, global positioning systems and computer systems) • Fabric, such as rear decks, upholstery, headliners, automobile seats, head rests, sun visors, trim panels and carpets • Wire harnesses, connectors and insulation tape • Engine fan case rub strip products and void-filling and edge-sealing products • Aircraft engine manufacturing repairs, electrical items • Structural panels and aircraft cabin interiors	
Space	Plastics containing DP	Manufacture of parts and repair	• Satellites, probes and other exploration equipment • Manned cabins and laboratories • Heat-insulating materials for rocket motors and ground support equipment	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Defence	Plastics containing DP	Manufacture and repair of parts for equipment	• Naval vessels, missiles, launch platforms, ordnance, communication equipment, radar and lidar systems and support equipment	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air

Group	Source materials /substances used	Applications	End products	Release media
WASTE RECYCLING AND DISPOSAL				
Electrical- and electronic-waste dismantling	Electrical and electronic waste (such as electrical and electronic plastic shells, circuit boards, wire and PUR foams)	Dismantling Shredding Separation	Metals Plastics Shredder residues	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
End-of-life vehicles (cars, aircraft, trains and ships)	End-of-life vehicles (such as electrical and electronic components, fuel system applications, pyrotechnical devices and applications, suspension and interior applications, reinforced plastics and fabrics, lead-acid batteries)	Dismantling Shredding Separation	Metals Plastics Textiles Shredder residues	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Construction and demolition waste	Construction and demolition waste (e.g., cold-bridge insulation, floors, basement walls and foundations, inverted roofs, ceilings, cavity insulation, composite panels and laminates, roofing materials such as membranes and films, epoxy adhesives, electrical insulation, commercial-grade carpeting)	Shredding Separation	Metals Plastics Textiles Shredder residues	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Textile and furniture waste	Textile and furniture waste (e.g., residential and commercial upholstered furniture, wall coverings and draperies, protective clothing and other technical textiles and tents)	Dismantling Shredding Separation	Plastics Foams Textiles Shredder residues	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air
Waste-plastic recycling	Waste plastic: • Polyolefins (PE, PP, EVA) • Styrenics (PS, HIPS, ABS) • Engineering thermoplastics (PET, PBT, PA, PC, PC-ABS, PEE-HIPS)	Recycling	Plastic	Solid waste Landfill leachate Liquid industrial and household cleaning waste Wastewater Sludge Air

Group	Source materials /substances used	Applications	End products	Release media
	• Thermosets (UPE, epoxies, melamine-based resins, PDAP) • Elastomers (EPDM rubber, thermoplastic PUR, EVA, SBR, silicone rubber, neoprene) • Waterborne emulsions and coatings (acrylic-, PVC-, ethylene vinyl chloride- and urethane-emulsion) • Nylon			

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

~~Article 1 (Scope of the Convention) defines the types of waste that are subject to the Basel Convention. Subparagraph 1 (a) of that Article sets forth a two-step process for determining whether a waste is a hazardous waste subject to the Convention. First, the waste must belong to any category contained in Annex I to the Convention (Categories of wastes to be controlled). Second, the waste must possess at least one of the characteristics listed in Annex III to the Convention (List of hazardous characteristics).~~

36. According to article 1 ("Scope of the Convention"), the Basel Convention covers two types of waste subject to transboundary movement: "hazardous wastes" and "other wastes". Paragraph 1 of Article 1 reads as follows:

(a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and

(b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.

37. As stated in Article 1, paragraph 2, "Wastes that belong to any category contained in Annex II that are subject to transboundary movement shall be "other wastes" for the purposes of this Convention".

~~29.~~38. Annex I and Annex II (Categories of wastes requiring special consideration) list some of the ~~wastes that may consist of, contain or be contaminated with~~ POP-BDEs or DP wastes:

(a) Y9: Waste oils/water, hydrocarbons/water mixtures, emulsions;

(b) Y12: Wastes from production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish;

(c) Y13: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives;

(d) Y18: Residues arising from industrial waste disposal operations;

(e) Y40: Ethers;

(f) Y45: Organohalogen compounds other than substances referred to in Annex I (e.g. Y39, Y41, Y42, Y43, Y44);

(g) Y46: Wastes collected from households;

(h) Y48: plastic waste[12]

[12] Refer to Annex II of the Basel Convention for a full description of this entry. Note the related entry A3210 in Annex VIII and B3011 in Annex IX

~~(g)~~(i) Y49: Electrical and electronic waste[13].

39. Annex I wastes are presumed to exhibit one or more Annex III hazardous characteristics, which may include H6.1 "Poisonous (Acute), H11 "Toxic (Delayed or chronic)", H12 "Ecotoxic" or H13 "Capable, by any means, after disposal, of yielding a material, e.g., leachate, which possesses any of the characteristics listed above", unless, through "national tests," they can be shown not to exhibit such characteristics. National tests may be useful for identifying a particular hazardous characteristic listed in Annex III until such time as the hazardous characteristic is fully defined. Guidance documents for Annex III hazardous characteristics H11, H12 and H13 were adopted on an interim basis by the Conference of the Parties to the Basel Convention at its sixth and seventh meetings.

~~30.~~40. At its fourth meeting in February 1998, the Conference of the Parties added the two lists of wastes as two new annexes to the Convention, namely Annex VIII (list A) and Annex IX (list B). These were intended to provide greater certainty and clarity to the entries. List A and List B are kept under review by the Conference of the Parties; in addition, a process was established under Decision BC VIII/15 of the Conference of the Parties to the Basel Convention to facilitate the identification and agreement on new entries.

~~31.~~41. List A of Annex VIII describes wastes that are "characterized as hazardous under Article 1, paragraph 1 (a) of this Convention", although "their designation on this Annex does not preclude the use of Annex III to demonstrate that a waste is not hazardous". However, Annex I and Annex III remain the factors to characterize wastes as hazardous for the purpose of this Convention, and that List A and List B are not intended to be exhaustive. List A of Annex VIII includes a number of wastes or waste categories that have the potential to contain or be contaminated with POP-BDEs, including:

(a) A1180: Waste electrical and electronic assemblies or scrap[14] containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g., cadmium, mercury, lead, PCB) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B, B1110)[15,16];

~~(a)~~(b) A1181: Electrical and electronic waste (note the related entry Y49 in Annex II)[17];

~~(b)~~(c) A1190: Waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCB,[18] lead, cadmium, other organohalogen compounds or other Annex I constituents to an extent that they exhibit Annex III characteristics;

~~(c)~~(d) A3050: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives excluding such wastes specified on list B (note the related entry on list B, B4020);

(e) A3080: Waste ethers not including those specified on list B;

~~(d)~~(f) A3210: Plastic waste, including mixtures of such waste, containing or contaminated with Annex I constituents, to an extent that it exhibits an Annex III characteristic (note the related entries Y48 in Annex II and on list B B3011).

~~(e)~~(g) A4070: Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish, excluding any such waste specified on list B (note the related entry on list B, B4010);

~~(f)~~(h) A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics;

~~(g)~~(i) A4140: Waste consisting of or containing off-specification or outdated[19] chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics;

[13] Refer to~~See~~ Annex II of the Basel Convention for a full description of this entry. Note the related entry A1181 in Annex VIII

[14] This entry does not include scrap from electrical power generation.

[15] PCB at a concentration level of 50 mg/kg or more.

[16] Basel entry A1180 will no longer exist from 1 January 2025, except where one or more Parties to the Basel Convention have notified, according to Article 18(2)(b) of the Convention, that they are unable to accept the e-waste amendments referred to in Decision BC-15/18.

[17] Refer to Annex VIII of the Basel Convention for a full description of this entry.

[18] PCBs are at a concentration level of 50 mg/kg or more.

[19] "Outdated" means unused within the period recommended by the manufacturer.

(j) A4160: Spent activated carbon not included on list B (note the related entry on list B, B2060);

(k) A1160 Waste lead-acid batteries, whole or crushed;

~~(h)~~(l) A1170 Unsorted waste batteries excluding mixtures of only list B batteries. Waste batteries not specified on list B containing Annex I constituents to an extent to render them hazardous.

~~32.~~42. List B of Annex IX includes wastes that "will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic" List B includes a number of wastes or waste categories that have the potential to contain or be contaminated with POP-BDEs or DP, including:

(a) B1110: Electrical and electronic assemblies[20]:

(i) Electronic assemblies consisting only of metals or alloys;

(ii) Waste electrical and electronic assemblies or scrap[21] (including printed circuit boards) not containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB capacitors, or not contaminated with Annex I constituents (e.g., cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the characteristics contained in Annex III (note the related entry on list A, A1180);

(iii) Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse and not for recycling or final disposal;[22]

(b) B1115: Waste metal cables coated or insulated with plastics, not included in list A, A1190, excluding those destined for Annex IVA operations or any other disposal operations involving, at any stage, uncontrolled thermal processes, such as open burning;

(c) B1250: Waste end-of-life motor vehicles, containing neither liquids nor other hazardous components;

(d) B2060: Spent activated carbon not containing any Annex I constituents to the extent they exhibit Annex III characteristics, for example, carbon resulting from the treatment of potable water and processes of the food industry and vitamin production (note the related entry on list A, A4160);

(e) B3011: Plastic waste (note the related entries Y48 in Annex II and on list A A3210)~~B3010: Solid plastic waste~~;[23]

(f) B3030: Textile wastes;[24]

(g) B3035: Waste textile floor coverings, carpets;

(h) B3040: Rubber wastes – the following materials, provided they are not mixed with other wastes:

(i) Waste and scrap of hard rubber (e.g., ebonite);

(ii) Other rubber wastes (excluding such wastes specified elsewhere);

(i) B3080: Waste parings and scrap of rubber;

(j) B4010: Wastes consisting mainly of water-based/latex paints, inks and hardened varnishes not containing organic solvents, heavy metals or biocides to an extent to render them hazardous (note the related entry on list A, A4070);

(k) B4020: Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives, not listed on list A, free of solvents and other contaminants to an extent that they do

[20] Basel entry B1110 will no longer exist from 1 January 2025, except where one or more Parties to the Basel Convention have notified, according to Article 18(2)(b) of the Convention, that they are unable to accept the e-waste amendments referred to in Decision BC-15/18.

[21] This entry does not include scrap from electrical power generation.

[22] In some countries, these materials destined for direct re-use are not considered wastes.

[23] Refer to~~See~~ Annex IX to the Basel Convention for a full description of this entry.

[24] Ibid.

not exhibit Annex III characteristics, e.g., water-based, or glues based on casein, starch, dextrin, cellulose ethers, polyvinyl alcohols (note the related entry on list A, A3050).

~~33.~~43. For further information, see section II.A of the general technical guidelines and Technical guidelines on the environmentally sound management of plastic wastes (UNEP, 2023).

B. Stockholm Convention

~~34.~~44. The present document covers intentionally produced POP-BDEs and DP, the production and use of which are to be eliminated in accordance with Article 3 of the Stockholm Convention and part I of Annex A to that convention.

1. HexaBDE and heptaBDE, and tetraBDE and pentaBDE

~~35.~~45. In part III of Annex A, hexaBDE and heptaBDE, and tetraBDE and pentaBDE, are defined as follows:

(a) "Hexabromodiphenyl ether and heptabromodiphenyl ether" means 2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153, CAS No: 68631-49-2), 2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154, CAS No: 207122-15-4), 2,2',3,3',4,5',6-heptabromodiphenyl ether (BDE-175, CAS No: 446255-22-7), 2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183, CAS No: 207122-16-5) and other hexa- and heptabromodiphenyl ethers present in commercial octabromodiphenyl ether;

(b) "Tetrabromodiphenyl ether and pentabromodiphenyl ether" means 2,2',4,4'-tetrabromodiphenyl ether (BDE-47, CAS No: 5436-43-1) and 2,2',4,4',5-pentabromodiphenyl ether (BDE-99, CAS No: 60348-60-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether.

~~36.~~46. Part IV of Annex A to the Stockholm Convention outlines specific requirements for hexaBDE and heptaBDE, as follows:

"1. A Party may allow recycling of articles that contain or may contain hexabromodiphenyl ether and heptabromodiphenyl ether, and the use and final disposal of articles manufactured from recycled materials that contain or may contain hexabromodiphenyl ether and heptabromodiphenyl ether, provided that:

(a) The recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of hexabromodiphenyl ether and heptabromodiphenyl ether for the purpose of their reuse;

(b) The Party takes steps to prevent exports of such articles that contain levels/concentrations of hexabromodiphenyl ether and heptabromodiphenyl ether exceeding those permitted for the sale, use, import or manufacture of those articles within the territory of the Party; and

(c) The Party has notified the Secretariat of its intention to make use of this exemption;

2. At its sixth ordinary meeting and at every second ordinary meeting thereafter the Conference of the Parties shall evaluate the progress that Parties have made towards achieving their ultimate objective of elimination of hexabromodiphenyl ether and heptabromodiphenyl ether contained in articles and review the continued need for this specific exemption. This specific exemption shall in any case expire at the latest in 2030."

~~37.~~47. Part V of Annex A to the Stockholm Convention outlines specific requirements for tetraBDE and pentaBDE, as follows:

"1. A Party may allow recycling of articles that contain or may contain tetrabromodiphenyl ether and pentabromodiphenyl ether, and the use and final disposal of articles manufactured from recycled materials that contain or may contain tetrabromodiphenyl ether and pentabromodiphenyl ether, provided that:

(a) The recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of tetrabromodiphenyl ether and pentabromodiphenyl ether for the purpose of their reuse;

(b) The Party does not allow this exemption to lead to the export of articles containing levels/concentrations of tetrabromodiphenyl ether and pentabromodiphenyl ether that exceed those permitted to be sold within the territory of the Party; and

(c) The Party has notified the Secretariat of its intention to make use of this exemption.

2. At its sixth ordinary meeting and at every second ordinary meeting thereafter the Conference of the Parties shall evaluate the progress that Parties have made towards achieving their ultimate objective of elimination of tetrabromodiphenyl ether and pentabromodiphenyl ether contained in articles and review the continued need for this specific exemption. This specific exemption shall in any case expire at the latest in 2030."

2. DecaBDE

~~38.~~48. In Part I of Annex A, decaBDE is defined as follows: ~~"~~"Decabromodiphenyl (BDE-209) present in commercial decabromodiphenyl ether".

~~39.~~49. Part I of Annex A also establishes the specific exemptions for the production and use of decaBDE as follows:

"Production: As allowed for the parties listed in the Register"

"Use: In accordance with Part IX of this Annex:

- Parts for use in vehicles specified in paragraph 2 of Part IX of this Annex;
- Aircraft for which type approval has been applied for before December 2018 and has been received before December 2022 and spare parts for those aircraft;
- Textile products that require anti-flammable characteristics, excluding clothing and toys;
- Additives in plastic housings and parts used for heating home appliances, irons, fans, immersion heaters that contain or are in direct contact with electrical parts or are required to comply with fire-retardancy standards, at concentrations lower than 10 per cent by weight of the part;
- Polyurethane foam for building insulation."

~~40.~~50. Part IX of Annex A outlines specific requirements for decaBDE as follows:

"1. The production and use of decabromodiphenyl ether shall be eliminated except for Parties that have notified the Secretariat of their intention to produce and/or use it in accordance with Article 4.

2. Specific exemptions for parts for use in vehicles may be available for the production and use of commercial decabromodiphenyl ether limited to the following:

(a) Parts for use in legacy vehicles, defined as vehicles that have ceased mass production, and with such parts falling into one or more of the following categories:

(i) Powertrain and under-hood applications such as battery mass wires, battery interconnection wires, mobile air-conditioning (MAC) pipes, powertrains, exhaust manifold bushings, under-hood insulation, wiring and harness under hood (engine wiring, etc.), speed sensors, hoses, fan modules and knock sensors;

(ii) Fuel system applications such as fuel hoses, fuel tanks and fuel tanks under body;

(iii) Pyrotechnical devices and applications affected by pyrotechnical devices such as air bag ignition cables, seat covers/fabrics (only if airbag relevant) and airbags (front and side);

(iv) Suspension and interior applications such as trim components, acoustic material and seat belts;

(b) Parts in vehicles specified in paragraphs 2 (a) (i)-(iv) above and those falling into one or more of the following categories:

(i) Reinforced plastics (instrument panels and interior trim);

(ii) Under the hood or dash (terminal/fuse blocks, higher-amperage wires and cable jacketing (spark plug wires));

(iii) Electric and electronic equipment (battery cases and battery trays, engine control electrical connectors, components of radio disks, navigation satellite systems, global positioning systems and computer systems);

(iv) Fabric such as rear decks, upholstery, headliners, automobile seats, head rests, sun visors, trim panels, carpets.

3. The specific exemptions for parts specified in paragraph 2 (a) above shall expire at the end of the service life of legacy vehicles or in 2036, whichever comes earlier.

4. The specific exemptions for parts specified in paragraph 2 (b) above shall expire at the end of the service life of vehicles or in 2036, whichever comes earlier.

5. The specific exemptions for spare parts for aircraft for which type approval has been applied for before December 2018 and has been received before December 2022 shall expire at the end of the service life of those aircraft."

3. Dechlorane Plus

51. In Part I of Annex A, DP is defined as follows: "Dechlorane Plus CAS No. 13560-89-9. "Dechlorane Plus" includes its *syn*-isomer (CAS No. 135821-03-3) and its *anti*-isomer (CAS No. 135821-74-8)".

52. Part I of Annex A does not allow for production of DP but establishes the specific exemptions for the use of DP as follows:

"Production: None"

"Use: In accordance with Part XI of this Annex:

- Aerospace
- Space and defence applications
- Medical imaging and radiotherapy devices and installations
- Replacement parts for, and repair of, articles in applications in accordance with the provisions of paragraphs 2 and 3 of part XI of this Annex".

53. Part XI of Annex A outlines conditions for DP use in replacement parts and repair of articles as follows:

"1. The use of Dechlorane Plus shall be eliminated except for Parties that have notified the Secretariat of their intention to use it in accordance with Article 4.

2. Specific exemptions for the use of Dechlorane Plus for replacement parts for, and repair of, articles shall apply where Dechlorane Plus was originally used in the manufacture of those articles and may be available, limited to the following applications, until the end of the service life of the articles or 2044, whichever comes earlier:

(a) Aerospace (such as aircraft engine fan case rub strip products and void filling and edge-sealing products, aircraft engine manufacturing repairs, electrical items, structural panels and aircraft cabin interiors);

(b) Space (such as satellites, probes and other exploration equipment, manned cabins and laboratories, heat-insulating materials for rocket motors and ground support equipment);

(c) Defence (such as naval vessels, missiles, launch platforms, ordnance, communication equipment, radar and lidar systems and support equipment);

(d) Motor vehicles (covering all land-based vehicles, such as cars, motorcycles, agricultural and construction vehicles and industrial trucks; applications include cables, wire harnesses, connectors and insulation tapes);

(e) Stationary industrial machines (such as tower cranes, concrete plants and hydraulic crushers; applications include cables, wire harnesses, connectors and insulation tapes) for use in agriculture, forestry and construction;

(f) Marine, garden, forestry and outdoor power equipment;

(g) Instruments for analysis, measurements, control, monitoring, testing, production and inspection.

3. Specific exemptions for the use of Dechlorane Plus for replacement parts for, and repair of, articles shall apply where Dechlorane Plus was originally used in the manufacture of those articles and may be available, limited to the following applications, until the end of the service life of those articles, subject to review by the Conference of the Parties no later than 2041:

(a) Medical devices (such as ultrasound diagnostic devices, magnetic resonance imaging systems, X-ray imaging systems, flexible endoscopes and radiotherapy devices and installations);

(b) In-vitro diagnostic devices (such as immunoassay analysers, haematology analysers, polymerase chain reaction (PCR) testing systems, genetic analysers, clinical chemistry analysers, blood coagulation analysers and urinalysis analysers).”

~~41.~~54. Information on the register of specific exemptions for POP-BDEs and DP is available on the website of the Stockholm Convention (www.pops.int).

~~42.~~55. For further information, see section II.B of the general technical guidelines.

III. Issues under the Stockholm Convention to be addressed cooperatively with the Basel Convention

A. Low POP content

~~43.~~56. The provisional definition of low POP content for hexaBDE, heptaBDE, ~~pentaBDE and~~ tetraBDE and pentaBDE [25] is 50 mg/kg or 1000 mg/kg as a sum. The provisional definition of low POP content for hexaBDE, heptaBDE, tetraBDE, pentaBDE and decaBDE is [50 mg/kg as a sum] [500 mg/kg as a sum] ~~[or]~~ [1,000 mg/kg as a sum][26]. The provisional definition of low POP content for DP is [XX] mg/kg.

~~44.~~57. The low POP content described in the Stockholm Convention is independent from the provisions on hazardous wastes under the Basel Convention.

~~45.~~58. Wastes with a content of POP-BDEs at or above 50 mg/kg or 1000 mg/kg as a sum for hexaBDE, heptaBDE, tetraBDE and pentaBDE, or [50 mg/kg as a sum] [500 mg/kg as a sum] ~~[or]~~ 1,000 mg/kg~~,~~ as a sum] for hexaBDE, heptaBDE, tetraBDE, pentaBDE and decaBDE, or DP at or above [XX] mg/kg, must be disposed of in such a way that the POP content is destroyed or irreversibly transformed in accordance with the methods described in subsection IV.G.2 of the present guidelines. They should otherwise be disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option in accordance with the methods described in subsection IV.G.3 of the present guidelines.

~~46.~~59. Wastes with a content of POP-BDEs below ~~[50 mg/kg] [500 mg/kg] [or] 1,000 mg/kg, as a sum~~50 mg/kg or 1000 mg/kg as a sum for hexaBDE, heptaBDE, tetraBDE and pentaBDE, or [50 mg/kg as a sum] [500 mg/kg as a sum] [1,000 mg/kg as a sum] for hexaBDE, heptaBDE, tetraBDE, pentaBDE and decaBDE, or DP below [XX] mg/kg, should be disposed of in accordance with the methods referred to in subsection IV.G.4 of the general technical guidelines (outlining disposal

[25] The current limit values for tetraBDE, pentaBDE, hexaBDE and heptaBDE may be kept if an individual value for decaBDE is agreed or no agreement is reached with respect to decaBDE.

[26] Determined in accordance with national or international methods and standards. In addition, a limit value has been set for the sum of tetraBDE, pentaBDE, hexaBDE and heptaBDE, because the commercial mixtures of those substances have varying congener composition (see subsection I.B.1 of the present guidelines) and to achieve analytical efficiencies. Further work to agree on a single value will be undertaken in accordance with decision BC-12/3 by the Conference of the Parties to the Basel Convention.

methods when POP content is low), taking into account subsection IV.I.1 of the present guidelines (pertinent to higher-risk situations).

~~47.~~60. For further information, see section III.A of the general technical guidelines.

B. Levels of destruction and irreversible transformation

~~48.~~61. For the provisional definition of levels of destruction and irreversible transformation, see section III.B of the general technical guidelines.

C. Methods that constitute environmentally sound disposal

~~49.~~62. See section IV.G of the present guidelines and section IV.G of the general technical guidelines.

IV. Guidance on environmentally sound management

A. General considerations

~~50.~~63. For information, see section IV.A of the general technical guidelines.

B. Legislative and regulatory framework

~~51.~~64. Parties to the Basel and Stockholm conventions should examine their national strategies, policies, controls, standards and procedures to ensure that they are in accordance with the provisions of the two conventions and with their obligations thereunder, including those that pertain to ESM of POP-BDEs or DP wastes.

~~52.~~65. Elements of a regulatory framework applicable to POP-BDEs or DP should include measures to prevent the generation of wastes and to ensure the ESM of generated wastes. Such elements could include:

(a) Environmental-protection legislation establishing a regulatory regime, setting release limits and establishing environmental quality criteria;

(b) Prohibitions and/or legal and administrative measures to eliminate the production, sale, use, import and export of POP-BDEs and DP in accordance with Article 3 of and Annex A to the Stockholm Convention, except in the case of Parties that have notified the Secretariat of their intention to use or produce decaBDE in accordance with the time-limited specific exemptions listed in Annex A to the Stockholm Convention;

(c) A requirement that best available techniques (BAT) and best environmental practices (BEP) be employed in the production and use of decaBDE, or use of DP, in cases where Parties have notified the Secretariat of their intention to use or produce decaBDE or DP in accordance with the time-limited exemptions listed in Annex A to the Stockholm Convention;

(d) Measures to ensure that POP-BDEs or DP wastes cannot be disposed of in ways that may lead to recovery, recycling, reclamation, direct reuse or alternative uses other than those subject to the specific exemptions listed in Annex A to the Stockholm Convention;

(e) Measures related to the recycling of articles that contain or may contain hexaBDE and heptaBDE, or tetraBDE and pentaBDE (see parts IV and V of Annex A to the Stockholm Convention) in case that Parties have registered for a specific exemption, set to expire at the latest in 2030;

(f) Transportation requirements for hazardous materials and waste;

(g) Specifications for containers, equipment, bulk containers and storage sites;

(h) Specification of acceptable analytical and sampling methods for POP-BDEs or DP;

(i) Requirements for waste-management and disposal facilities;

(j) Definitions of hazardous waste, and conditions and criteria for the identification and classification of POP-BDEs or DP wastes as hazardous wastes;

(k) A general requirement for public notification and review of proposed government waste-related regulations, policies, certificates of approval, licences, inventory information and national releases and emissions data;

(l) Requirements for identification, assessment and remediation of contaminated sites;

(m) Requirements concerning the health and safety of workers;

(n) Legislative measures on, for example, waste prevention and minimization, inventory development and emergency response.

~~53.~~66. Legislation should include a time limit for disposal of POP-BDEs or DP wastes so as to prevent the creation of stockpiles that have no clear phase-out dates.

~~54.~~67. For further information, see section IV.B of the general technical guidelines.

C. Waste prevention and minimization

~~55.~~68. Both the Basel and Stockholm conventions advocate waste prevention and minimization. The production and use of POP-BDEs or DP are to be eliminated under the Stockholm Convention, unless they fall under the limited specific exemptions for their use listed in Annex A to that Convention.

~~56.~~69. Quantities of waste containing POP-BDEs or DP should be minimized through isolation and separation of those wastes from the other wastes at source to prevent their mixing with, and contamination of, other waste streams.

70. ~~The mixing and blending of wastes with POP-BDE content at or above [50 mg/kg] [500 mg/kg] [or] 1,000 mg/kg, as a sum, with other materials solely for the purpose of generating a mixture with a POP-BDE content below [50 mg/kg] [500 mg/kg] [or] 1,000 mg/kg, as a sum, are not environmentally sound. Nevertheless, the mixing or blending of materials as a pre-treatment method may be necessary in order to enable treatment or to optimize treatment efficiency.~~The mixing and blending of wastes with POP-BDEs or DP content at or above the established low POP content value with other materials solely for the purpose of generating a mixture with a POP-BDEs or DP content below established low POP content value, are not environmentally sound. Nevertheless, the mixing or blending of materials as a pre-treatment method may be necessary in order to enable treatment or to optimize treatment efficiency. Any blending of waste or mixing of material should use the minimum amount of other waste or material needed to enable or optimise treatment. Any reduction of concentration below the low POP content due to blending or mixing does not remove the requirement to destroy or irreversibly transform the POPs.

~~57.~~71. For further information, see section IV.C of the general technical guidelines.

D. Identification of wastes

~~58.~~72. Subparagraph 1 (a) of Article 6 of the Stockholm Convention requires each Party, inter alia, to develop appropriate strategies for the identification of products and articles in use and wastes consisting of, containing or contaminated with POPs. The identification of POP-BDEs or DP wastes is the starting point for their effective ESM.

~~59.~~73. For general information on identification and inventories, see section IV.D of the general technical guidelines.

~~60.~~74. Detailed guidance and information on establishing inventories for POP-BDEs is provided in the Guidance for the inventory of polybrominated diphenyl ethers listed under the Stockholm Convention on Persistent Organic Pollutants (UNEP, ~~2017b~~2021a). The objective of this document is to provide step-by-step guidance that enables Parties to establish inventories of hexaBDE and heptaBDE and tetraBDE and pentaBDE, listed under the Convention in 2009, as well as decaBDE listed in 2017, and provides updated information on known uses, information that could be useful for identifying POP-BDEs-containing wastes. Additional information on identification can also be found in Guidance on sampling, screening and analysis of persistent organic pollutants in products and recycling (UNEP, 2021b). Although not included in the document, much of the information is relevant for Dechlorane Plus due to similar uses.

1. Identification

~~61.~~75. POP-BDEs or DP wastes can be found at the following stages of the POP-BDEs or DP life cycle:

(a) POP-BDEs or DP manufacturing and processing:

(i) Wastes generated from the production and processing of ~~BDEs~~the flame retardants;

(ii) Water, soil or sediment close to manufacturing or processing sites;

(iii) Industrial wastewater and sludge;

(iv) Landfill leachate from sites where chemical-manufacturing or -processing waste has been disposed of;

(v) Stockpiles of unusable or unsellable material;

(b) Industrial applications of POP-BDEs and DP (including PUR foams, plastics for electrical and electronic equipment, building materials, vehicles, aircraft, trains and ships, textiles, adhesives, sealants, coatings, inks, wires and cables, pipes, carpets, upholstery, window blinds, curtains, mattresses):

(i) Residues generated from the application of POP-BDEs and DP;

(ii) Water, soil or sediment close to manufacturing or processing sites;

(iii) Industrial wastewater and sludge;

(iv) Landfill leachate from sites where wastes from industrial application has been disposed of;

(v) Stockpiles of unusable or unsellable products;

(c) Use of products or articles containing POP-BDEs or DP:

(i) Water, soil or sediment close to sites where such products have been used;

(d) Disposal of products or articles containing POP-BDEs or DP:

(i) In certain facilities for the collection, recycling and recovery of textiles, PUR foams and plastics for electronic and electrical equipment, building materials and vehicles;

(ii) In municipal landfill leachate;

(iii) In municipal wastewater and sludge.

~~62.~~76. It should be noted that even experienced technical personnel may not be able to determine the nature of an effluent, substance, container or piece of equipment by its appearance or markings. Consequently, Parties may find the information on production, use and types of waste provided in section I.B of the present guidelines useful for identifying POP-BDEs or DP wastes.

2. Inventories

~~63.~~77. A national inventory should, as appropriate, include data on:

(a) Production of POP-BDEs or DP within a country;

(b) Import and export of products and articles consisting of or containing POP-BDEs or DP;

(c) Disposal of POP-BDEs or DP wastes;

(d) Import and export of POP-BDEs or DP wastes.

~~64.~~78. Inventories are an important tool for identifying, quantifying and characterizing wastes. A step-by-step approach for the development of national inventories of POP-BDEs generally includes the following steps:

(a) Step 1: planning (i.e., identification of relevant sectors that use or produce POP-BDEs or DP);

(b) Step 2: choosing data-collection methodologies using a tiered approach;

(c) Step 3: collecting and compiling data from national statistics on the production, use, import and export of POP-BDEs or DP;

(d) Step 4: managing and evaluating the data obtained in step 3 using an estimation method;

(e) Step 5: preparing an inventory report;

(f) Step 6: periodically updating the inventory report.

~~65.~~79. For further information, see the Guidance for the inventory of polybrominated diphenyl ethers listed under the Stockholm Convention on Persistent Organic Pollutants (UNEP, 2017b).

E. Sampling, analysis and monitoring

~~66.~~80. For general information, see section IV.E of the general technical guidelines.

1. Sampling

~~67.~~81. Sampling plays an important role in identifying and monitoring environmental concerns and risks to human health.

~~68.~~82. Standard sampling procedures should be established and agreed upon before the start of a sampling campaign. Sampling should comply with specific national legislation, where it exists, or with international regulations and standards.

~~69.~~83. For waste electrical and electronic equipment (WEEE) a sampling method is described in CENELEC Technical Specification TS 50625-3-1: Collection, logistics and treatment requirements for WEEE – Part 3-1: Specification for de-pollution – General.[27] For plastic from electrical and electronic equipment and WEEE – the main products and articles contaminated with POP-BDEs (and to a lesser extent DP) – a detailed sampling methodology and a sampling protocol has been developed and is described in Wäger et al. (2010). This sampling strategy and protocol can be applied (in a modified way) in other countries and regions that have shredder plants with related WEEE-plastic shredder fractions. An approach to sampling that uses a single piece of electrical and electronic equipment for the screening of POP-BDEs or DP in, for example, cathode-ray-tube casings of televisions and personal computers is described briefly in annex 3-B to the Draft guidance on sampling, screening and analysis of persistent organic pollutants in products and ~~articles~~ recycling (UNEP, ~~2017d~~2021b). Strategies for sampling, along with the mechanical preparation of samples from electrotechnical products, electronic assemblies and electronic components, are provided in standard IEC 62321-2:2013: Determination of certain substances in electrotechnical products – Part 2: Disassembly, disjunction and mechanical sample preparation, of the International Electrotechnical Commission.

~~70.~~84. Types of matrix that are typically sampled for POP-BDEs or DP include:

(a) Liquids:

(i) Leachate from dumpsites and landfills;

(ii) Water (surface water, drinking water and industrial effluents);

(iii) Waterborne emulsions containing or contaminated with POP-BDEs or DP;

(iv) Rinse solution;

(b) Solids:

(i) ABS, HIPS and other types of flame-retardant polymers (wastes from production processes);

(ii) ABS, HIPS and other types of WEEE plastics;

(iii) PUR foam, textile, rubber (from end-of-life vehicles);

(iv) Shredding materials and residues;

(v) Solids from treatment or disposal processes (fly ash, bottom ash, sludge, still bottoms, other residues, clothing, etc.);

(vi) Soil, sediment, rubble, sewage sludge and compost;

~~(vi)~~(vii) Plastic recyclates.

(c) Gases:

(i) Air (indoor and outdoor);

(ii) Exhaust gas.

2. Analysis

~~71.~~85. Analysis refers to the extraction, purification, separation, identification, quantification and reporting of POP ~~BDE~~ concentrations in the matrix of interest. In order to obtain meaningful and

[27] The standard can be purchased via the website of a national CENELEC member https://standards.cencenelec.eu/dyn/www/f?p=CEN:5~~(https://www.cenelec.eu/dyn/www/f?p=WEB:5:100611388568110~~1~~).~~

acceptable results, analytical laboratories should have the necessary infrastructure (housing) and proven experience.

~~72.~~86. The development and dissemination of reliable analytical methods and the accumulation of high-quality analytical data are important for understanding the environmental impact of hazardous chemicals, including POPs.

~~73.~~87. X-ray fluorescence (XRF) and sliding spark analysis can be used as inexpensive and rapid screening methods to determine whether a material contains bromine or chlorine. These methods, however, will not serve to identify the ~~types of chemicals~~ compound that contain bromine or chlorine. Waste that has been processed in saltwater density sorting will contain chlorine from the salt (NaCl) making the use of XRF of lesser utility for the screening for DP. This can be mitigated by thorough rinsing and drying prior to analysis. XRF can also not distinguish the chlorine of DP in a chlorinated polymer such as polyvinyl chloride (PVC).

~~74.~~88. Chemical analysis of POP-~~P~~PBDEs is usually done using gas chromatography coupled with mass spectrometry in different variations in order to optimize the analysis according to the specific matrix concerned (UNEP, 2017~~de~~). In the toxicological profile for POP-BDEs, the Agency for Toxic Substances and Disease Registry provides a summary of identified and well-established methods that are used as standard methods for analysing POP-BDEs. Additionally, analytical methods that modify previously used methods to obtain lower detection limits and/or to improve accuracy and precision have been included (ATSDR, 2017). Further information on analytical methods for POP-BDEs is provided in the ~~Draft g~~Guidance on sampling, screening and analysis of persistent organic pollutants in products and ~~articles~~ recycling (UNEP, 2021b ~~2017d~~).

~~75.~~89. Standardized methods of analysing the various matrices for POP-BDEs have been developed by the International Organization for Standardization (ISO) and by national authorities such as the United States Environmental Protection Agency (USEPA). Table 3 contains some methods that can be used for analysing POP-BDEs in products, wastes, sediments, flue gas and wastewater.

Table 3
Analytical methods of PBDEs

Standard No.	*Analytical method*
DIN EN 16694: 2015-12	Water quality – Determination of selected PBDE in whole water samples – Method using solid phase extraction (SPE) with SPE-disks combined with gas chromatography/mass spectrometry
USEPA Method 1614 A	Brominated diphenyl ethers in water, soil, sediment, and tissue by high-resolution gas chromatography/high-resolution mass spectrometry
USEPA Method 527	Determination of selected pesticides and flame retardants in drinking water by solid phase extraction and capillary column gas chromatography/mass spectrometry
USEPA 8270D	Semi-volatile organic compounds by gas chromatography/mass spectrometry
IEC 62321-3-1:2013	Determination of certain substances in electrotechnical products – Part 3-1: Screening – Lead, mercury, cadmium, total chromium and total bromine using X-ray fluorescence spectrometry
IEC 62321-3-2:2013	Determination of certain substances in electrotechnical products – Part 3-2: Screening – Total bromine in polymers and electronics by combustion-ion chromatography
IEC 62321-6:2015	Determination of certain substances in electrotechnical products – Part 6: Polybrominated biphenyls and PBDEs in polymers by gas chromatography/mass spectrometry
ISO 22032: 2013	Water quality – Determination of selected PBDEs in sediments and sewage sludge – Method using extraction and gas chromatography/mass spectrometry
China GB/Z 21277-2007	Rapid screening of lead, mercury, chromium, cadmium and bromine of regulated substances in electrical and electronic equipment – X-ray fluorescence spectrometry

90. Analytical methods are available for the detection of DP in both abiotic and biotic environmental media (Ayala-Cabrera et al., 2021; UNEP, 2017f). For analysis of articles, products and materials, although there are no standardized analytical methods, it is possible to analytically determine DP, via suitable extraction/cleanup procedures and established mass spectrometric methods that combine gas chromatography with low- or high-resolution mass spectrometry (GC-LRMS or GC-HRMS), or tandem mass spectrometry (GC-MS/MS) (Norwegian Environment Agency, 2021; UNEP, 2022a).

91. Shimadzu Corporation (2023) investigated a possibility to analyze UV-328 and Dechlorane Plus with gas chromatography-mass spectrometry using a pyrolyzer/thermal desorption accessory (Py-TD-GC-MS), which is described in the International Electrotechnical Commission (IEC) standard IEC

62321-8:2017 developed to determine phthalates in polymers. They found that the Py/TD-GC-MS method is sensitive enough and offers sufficient quantitative accuracy to determine whether the additives are present in samples or not. Py/TD-GC-MS can analyze plastic samples directly without solvent extraction and could provide a rapid and simple method of screening for UV-328 and Dechlorane Plus in plastics.

3. Monitoring

~~76.~~92. Monitoring and surveillance serve as means of identifying and tracking environmental concerns and risks to human health. Information collected from monitoring programmes feeds into science-based decision-making processes and is used for the evaluation of the effectiveness of risk-management measures, including regulations.

~~77.~~93. Monitoring programmes should be implemented in facilities managing POP-BDEs or DP wastes.

~~78.~~94. Information on monitoring and analysis of POP-BDEs in articles and products is described in the ~~Draft~~ gGuidance on sampling, screening and analysis of persistent organic pollutants in products and ~~articles~~ recycling (UNEP, 2021b ~~2017d~~). This document provides step-by-step guidance on monitoring (sampling, screening and analysis) articles, products and recycling streams. Although not specifically mentioned, much of the information is directly applicable to DP because of similar applications and analytics.

F. Handling, collection, packaging, labelling, transportation and storage

~~79.~~95. POP-BDEs or DP wastes should be handled, collected, packaged, labelled, transported and stored so as to prevent spills and leaks leading to worker exposure, releases into the environment or community exposure. The guidance on waste handling and collection in the present guidelines may not apply to POP-BDEs or DP wastes that are consumer or household wastes, such as WEEE, as it has not been documented that such wastes pose significant risks to the environment or human health during handling and collection.

~~80.~~96. For further information, see section IV.F of the general technical guidelines.

1. Handling

~~81.~~97. POP-BDEs or DP wastes should be handled separately from other types of waste in order to prevent contamination of other waste streams.

~~82.~~98. Organizations handling POP-BDEs or DP wastes should have in place procedures for handling such wastes and workers should be trained in those procedures.

2. Collection

~~83.~~99. Collection arrangements and collection depots for POP-BDEs or DP wastes should provide for the separation of POP ~~BDE~~ wastes from other wastes. In Europe, there exists CENELEC Technical Specification TS 50625-3-1: Collection, logistics and treatment requirements for WEEE.[28]

~~84.~~100. All POP-BDEs or DP wastes should be collected separately from those wastes that do not contain POP-BDEs or DP. Legal or other mechanisms may be required to ensure the efficient collection of POP- BDEs or DP wastes, such as WEEE, from households. For example, governments, producers of articles containing POP-BDEs and others could make arrangements for the collection of such wastes by local collectors.

~~85.~~101. Waste plastics containing POP-BDEs or DP from electrical and electronic waste recycling facilities should be collected separately during the dismantling process.

3. Packaging

~~86.~~102. POP-BDEs or DP wastes should be properly packaged for ease of transport and before storage as a safety measure to reduce the risk of leaks and spills. In preparation for transporting POP-BDEs or DP wastes, from the generators' premises or public collection points to waste treatment facilities, the wastes should be properly packaged.

[28] The standard can be purchased via the website of a national CENELEC member: https://standards.cencenelec.eu/dyn/www/f?p=CEN:5~~https://www.cenelec.eu/dyn/www/f?p=WEB:5:10061 13885681101.~~

(a) Packaging of solid POP-BDEs or DP wastes

~~87.~~103. The packaging of solid POP-BDEs or DP wastes could include corrugated cartons lined with protective anti-seepage plastic bags.

~~88.~~104. Special wooden pallets could be designed for use during storage to raise stored POP-BDEs or DP wastes above ground level and thereby protect them from moisture.

(b) Packaging of liquid POP-BDEs or DP wastes

~~89.~~105. POP-BDEs ~~contaminated~~ or DP-contaminated liquids can be packaged in special anti-seepage barrels.

(c) Packaging of POP-BDsE or DP contaminated soil

~~90.~~106. POP-BDEs ~~contaminated~~ or DP--contaminated soils can be packaged in triple-layered, anti-leak, high-strength laminated bags.

4. Labelling

~~91.~~107. ~~In cases where POP-BDEs or DP wastes are considered hazardous wastes, E~~every container ~~carrying POP-BDEs~~ or DP chemical wastes ~~should be clearly labelled with a hazard warning label and a label giving details of the container and a unique serial number. Such details should include the contents of the container (such as the exact quantities of equipment, volume, weight and type of waste carried), the name of the site from which the wastes originate so as to allow their traceability and, if applicable, the date of repackaging and the name and telephone number of the person responsible for the repackaging operation. The label should be indelible, clear and plainly visible.~~For information, see subsection IV.F.4 of the general technical guidelines.

5. Transportation

~~92.~~108. Appropriate measures should be taken to prevent scattering or leakage of POP-BDEs or DP wastes. Such wastes should be handled separately during transport to avoid their mixing with other materials.

~~93.~~109. Transporters should employ trained and qualified drivers, loading- and unloading-management personnel and escort personnel, all of whom should carry their qualification certificates.

~~94.~~110. Waste transporters should provide full and accurate information about their cargoes or shipments, transfer wastes safely to their destinations and hand them over to receivers in accordance with national regulations.

6. Storage

~~95.~~111. POP-BDEs or DP wastes should be stored in designated sites and appropriate measures should be taken at such sites to prevent scattering, leakage and underground seepage of POP-BDEs or DP.

~~96.~~112. Appropriate measures, such as the installation of partitions, should be taken in order to avoid contamination of other materials and wastes with POP-BDEs or DP.

~~97.~~113. POP-BDEs or DP wastes storage areas should be controlled areas with defined boundaries. Warning signs should be posted around such areas and access should be restricted to authorized personnel.

~~98.~~114. POP-BDEs or DP wastes storage areas should have adequate access roads for vehicles. Simple roads can be constructed when necessary.

~~99.~~115. Storage sites should have structures to prevent underground leakage of POP-BDEs or DP. Containers should be sealable, easy to store and durable. Storage sites should be maintained and inspected to verify whether there have been any releases of POP-BDEs or DP into the environment.

G. Environmentally sound disposal

1. Pre-treatment

~~100.~~116. Dismantling, disassembling and mechanical separation can be used to reduce the volume of POP-BDEs or DP wastes.

~~101.~~117. For further information, see subsection IV.G.1 of the general technical guidelines.

2. Destruction and irreversible transformation methods

~~Destruction and irreversible transformation methods for the environmentally sound disposal of wastes with a POP-BDE content at or above [50 mg/kg] [500 mg/kg] [or] 1,000 mg/kg, as a sum, according to the general technical guidelines, include:~~

~~(d) Advanced solid waste incineration;~~

~~(e) Cement kiln co-incineration;~~

~~(f) Hazardous waste incineration;~~

~~(g) Thermal and metallurgical production of metals;~~

~~(h) Supercritical water oxidation and subcritical water oxidation;~~

~~(i) Gas phase chemical reduction.~~

~~It should be noted that polybrominated dibenzo-p-dioxins (PBDDs)/ polybrominated dibenzofurans (PBDFs) can be generated from combustion and incineration of POP-BDE wastes~~.

118. For information on technologies recommended for destruction or irreversible transformation of POP-BDEs or DP wastes,~~further information~~, see subsection IV.G.2 of the general technical guidelines.

~~102.~~119. It should be noted that polybrominated dibenzo-*p*-dioxins (PBDDs)/ polybrominated dibenzofurans (PBDFs) can be generated from combustion and incineration of POP-BDEs wastes

3. Other disposal methods when destruction or irreversible transformation is not the environmentally preferable option

~~103.~~120. For information, see subsection IV.G.3 of the general technical guidelines.

4. Other disposal methods when the POP content is low

~~104.~~121. For information, see subsection IV.G.4 of the general technical guidelines.

H. Remediation of contaminated sites

~~105.~~122. Several remediation technologies are described in literature. These include in situ remediation such as electrokinetic and oxidation technologies and ex situ soil washing (see Wu et al., 2012; Ye M. et al., 2015a; Ye M. et al., 2015b; Li J. et al., 2016).

~~106.~~123. For further information, see section IV.H of the general technical guidelines.

I. Health and safety

~~107.~~124. For information, see section IV.I of the general technical guidelines.

1. Higher-risk situations

~~108.~~125. For general information, see subsection IV.I.1 of the general technical guidelines.

~~109.~~126. Higher-risk situations occur at sites where high concentrations of POP-BDEs or DP, or high volumes of POP-BDEs or DP wastes are found and there is a high potential for exposure of workers or the general population. Potential higher-risk situations specific to POP-BDEs or DP may occur at:

(a) Sites of POP-BDEs or DP production;

(b) Sites at which electrical and electronic wastes are dismantled;

(c) Sites at which waste plastic is shredded or recycled;

(d) Sites for storage or disposal of POP-BDEs or DP wastes.

2. Lower-risk situations

~~110.~~127. For information, see subsection IV.I.2 of the general technical guidelines.

J. Emergency response

~~111.~~128. Emergency response plans should be in place for POP-BDEs or DP in use, in storage, in transport or at disposal sites.

~~112.~~129. For further information, see section IV.J of the general technical guidelines.

K. Public participation

~~113.~~130. Parties to the Basel or Stockholm Convention should have open public-participation processes.

~~114.~~131. For further information, see section IV.K of the general technical guidelines.

Annex I to the technical guidelines

Trade names of commercial formulations that contain or have contained Dechlorane Plus (DP)

Dechlorane Plus; Dechlorane Plus 25 (Dech Plus); Dechlorane Plus 35 (Dech Plus-2); Dechlorane Plus 515; Dechlorane 605; Dechlorane Plus 1000; Dechlorane Plus 2520; Dechlorane A; DP; Escapeflam DK-15 (China); PyroVex SG (grade 515, 25 and 35)

Annex II to the technical guidelines

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