



Distr.: General

13 July 2015

Original: English

**Conference of the Parties to the Basel Convention
on the Control of Transboundary Movements of
Hazardous Wastes and Their Disposal
Twelfth meeting**

Geneva, 4–15 May 2015

Agenda item 4 (b) (i)

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

Technical guidelines

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

Note by the Secretariat

At its twelfth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal adopted, in decision BC-12/3 on technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants, the 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, on the basis of the draft technical guidelines contained in document UNEP/CHW.12/5/Add.6. The technical guidelines referred to above were prepared by China as lead country for this work, in close consultation with the small intersessional working group on the development of technical guidelines on persistent organic pollutants wastes and taking into account comments received from parties and others and comments provided at the ninth meeting of the Open-ended Working Group of the Basel Convention. The technical guidelines were further revised on 3 April 2015 taking into account comments received from parties and others by 23 January 2015, as well as the outcome of the face-to-face meeting of the small intersessional working group on the development of technical guidelines on persistent organic pollutants wastes held from 17 to 19 March 2015 in Ottawa, Canada (see document UNEP/CHW.12/INF/13). The text of the final version of the technical guidelines, as adopted, is set out in the annex to the present note.

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

Revised final version (15 May2015)

Contents

Abbreviations and acronyms	5
Units of measurement	5
I. Introduction	6
A. Scope	6
B. Description, production, use and wastes	6
1. Description	6
2. Production	7
3. Use	7
4. Wastes	8
II. Relevant provisions of the Basel and Stockholm conventions.....	10
A. Basel Convention	10
B. Stockholm Convention	11
III. Issues under the Stockholm Convention to be addressed cooperatively with the Basel Convention	12
A. Low POP content	12
B. Levels of destruction and irreversible transformation	13
C. Methods that constitute environmentally sound disposal	13
IV. Guidance on environmentally sound management (ESM).....	13
A. General considerations	13
B. Legislative and regulatory framework	13
C. Waste prevention and minimization	14
D. Identification of wastes	14
1. Identification	14
2. Inventories	15
E. Sampling, analysis and monitoring ..	15
1. Sampling	15
2. Analysis	16
3. Monitoring	16
F. Handling, collection, packaging, labelling, transportation and storage	16
1. Handling	17
2. Collection	17
3. Packaging	17
4. Labelling	17
5. Transportation	17
6. Storage	18
G. Environmentally sound disposal	18
1. Pre-treatment	18
2. Destruction and irreversible transformation methods	18
3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option	18
4. Other disposal methods when the POP content is low	18

H. Remediation of contaminated sites.....	18
I. Health and safety	18
1. Higher-risk situations.....	18
2. Lower-risk situations.....	19
J. Emergency response	19
K. Public participation.....	19
Annex: Bibliography.....	20

Abbreviations and acronyms

ABS	acrylonitrile-butadiene-styrene
BDE	brominated diphenyl ether
BFR	brominated flame retardant
C-decaBDE	commercial decabromodiphenyl ether
C-octaBDE	commercial octabromodiphenyl ether
C-pentaBDE	commercial pentabromodiphenyl ether
CAS	Chemical Abstracts Service
ESM	Environmentally sound management
HexaBDE	hexabromodiphenyl ether and
HeptaBDE	heptabromodiphenyl ether
HIPS	high-impact polystyrene
IEC	International Electrotechnical Commission
ILO	International Labor Organization
ISO	International Organization for Standardization
NonaBDE	nonabrominated diphenyl ether
OECD	Organisation for Economic Co-operation and Development
PBDD	polybrominated dibenzo-p-dioxin
PBDEs	polybrominated diphenyl ethers
PentaBDE	pentabromodiphenyl ether
POP-BDEs	hexabromodiphenyl ether and heptabromodiphenyl ether, and tetrabromodiphenyl ether and pentabromodiphenyl ether
PBDF	polybrominated dibenzofuran
PBT	polybutyleneterephthalate
PCB	polychlorinated biphenyl
POP	persistent organic pollutant
PP	polyamide polymers
PUR	polyurethane
TetraBDE	tetrabromodiphenyl ether
UNEP	United Nations Environment Programme
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

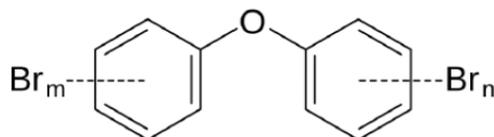
1. The present guidelines provide guidance on the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether, or tetrabromodiphenyl ether and pentabromodiphenyl ether, pursuant to several decisions of two multilateral environmental agreements on chemicals and wastes.¹
2. Hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE), as well as tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE), were listed in Annex A to the Stockholm Convention in 2009, through an amendment that entered into force in 2010. In the present guidelines, hexaBDE, heptaBDE, tetraBDE and pentaBDE as a group are referred to as “POP-BDEs”.
3. 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, 2015) (hereinafter referred to as “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 persistent organic pollutants (POPs) and provide more detailed information on the nature and incidence of wastes consisting of, containing or contaminated with POP-BDEs for purposes of their identification and management.

B. Description, production, use and wastes

1. Description

4. Brominated flame retardants (BFRs) are chemical substances used to reduce fire hazards by interfering with the combustion of the polymer. Some BFRs, such as polybrominated diphenyl ethers (PBDEs), are additives that do not chemically bind to plastics but are physically combined with them and therefore may be easily released into the environment.
5. PBDEs have different atomic numbers and degrees of bromination ranging from one to ten bromine atoms (figure 1). Lower brominated BDEs, such as tetraBDEs and pentaBDEs, are seen as more dangerous than higher brominated BDEs (i.e., BDEs with more than 5 bromine atoms per molecule, e.g., octaBDEs and decaBDEs) because they bioaccumulate more efficiently, are slightly more soluble in water and have a greater propensity for volatilization and atmospheric transport than higher brominated BDEs.

Figure 1: Structure of PBDEs



6. PBDEs are industrial aromatic organobromine chemicals that make up a group consisting of 209 congeners. The most common commercial formulations of PBDEs (represented in table 1 below) are commercial octabromodiphenyl ether (c-octaBDE), commercial pentabromodiphenyl ether (c-pentaBDE) and commercial decabromodiphenyl ether (c-decaBDE).
7. C-octaBDE designates a commercial mixture that typically contains mainly hexaBDEs, heptaBDEs, octaBDEs and nonabrominated diphenyl ethers (nonaBDEs). “Hexabromodiphenyl ether and heptabromodiphenyl ether” means, according to Annex A, part III, to the Stockholm Convention, BDE-153, BDE-154, BDE-175, BDE-183 and other hexa- and heptabromodiphenyl ethers present in c-octaBDE.
8. C-pentaBDE designates a commercial mixture that typically contains tetraBDEs, pentaBDEs and hexaBDEs. “Tetrabromodiphenyl ether and pentabromodiphenyl ether” means, according to

¹ Decisions BC-11/3 and BC-12/3 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 and OEWG-9/3 of the Open-ended Working Group of the Basel Convention; and decisions SC-4/14, SC-4/18, SC-5/9 and SC-6/11 of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants.

Annex A, part III, to the Stockholm Convention, BDE-47, BDE-99 and other tetra- and pentabromodiphenyl ethers present in c-pentaBDE.

9. There is some evidence that higher brominated BDEs such as decaBDE can break down to lower brominated congeners. These higher congeners may therefore be precursors to the POP-BDEs that fall under the scope of the present technical guidelines.

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%

2. Production

(a) C-octaBDE

10. Parties to the Stockholm Convention must prohibit and/or eliminate the production of hexaBDE and heptaBDE and there are no exemptions under the Convention for the production of those chemicals. C-octaBDE has been produced in France, Japan, Israel, 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 and had decreased to 3,800 tonnes by 2001. No information is available on whether c-octaBDE is being produced in developing countries (POPRC, 2008).

(b) C-pentaBDE

11. Parties of the Stockholm Convention must prohibit and/or eliminate the production of tetraBDE and pentaBDE and there are no exemptions under the Convention for the production of the chemical. C-pentaBDE was produced in Australia, the European Union, Israel and the United States, but production ceased in 2004 (UNEP/POPS/POPRC.2/17/Add.1).

3. Use

(a) C-octaBDE

12. Parties to the Stockholm Convention must 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 listed in part IV of Annex A to the Convention. HexaBDE and heptaBDE are still being used in accordance with the specific exemption listed in part IV of Annex A, which 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 of the Stockholm Convention on the Convention website (www.pops.int).

13. 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 housings of electrical and electronic equipment, such as office equipment, automotive parts and appliances, business machines, computers, business cabinets, pipes and fittings. A minor quantity is also being produced for use as an additive in high impact polystyrene (HIPS), polybutylene terephthalate (PBT) and polyamide polymers (PP) (POPRC, 2008).

(b) C-pentaBDE

14. Parties to the Stockholm Convention must 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 listed in part V of Annex A to the Convention. TetraBDE and pentaBDE are still being used in accordance with the specific exemption listed in part V of Annex A, 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).

15. 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, as well as Canada. Alcock et al. have estimated that up to 2000, 85,000 tonnes of pentaBDE overall were used in the United States and 15,000 tonnes were used in Europe (Alcock et al., 2003). PentaBDEs may have been used in Asia but no reliable data are available to confirm this.

16. 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. Flexible PUR foams were used mainly in automotive and upholstery applications, electrical and electronic appliances, building materials, furniture, textiles and packaging.

4. Wastes

17. Wastes consisting of, containing or contaminated with POP-BDEs (hereinafter referred to as "POP-BDE wastes") may be found in:

- (a) Solid obsolete stockpiles of POP-BDEs and their related substances in original packages that are no longer usable;
- (b) Solid wastes from producers and users of POP-BDEs;
- (c) Wastewater from industrial and municipal processes and residues from wastewater cleaning such as activated carbon treatment;
- (d) Products (e.g., electrical and electronic equipment, building materials, plastics, textiles, vehicles) that have become waste;
- (e) Municipal and industrial sludges; and
- (f) Landfill leachate.

18. Action aimed at waste streams of importance in terms of volume and concentration will be essential to eliminating, reducing and controlling the environmental load of POP-BDEs from waste management activities. In that context, the following should be recognized:

- (a) It is likely that POP-BDEs are released into the environment throughout their life cycles (production, product assembly, consumer use, and disposal, including recycling);
- (b) Waste management activities have been identified as one route through which POP-BDEs can enter the environment, mainly through industrial and municipal wastewater discharges to surface water and through leachate from landfills;
- (c) Wastes may contain variable concentrations of POP-BDEs, depending on the quantities in which POP-BDEs were originally present in specific products and the quantities released during product use and end-of-life management.

19. Waste streams of importance in terms of potential volume or concentration are:

- (a) PUR foams for the production of automotive and upholstery applications, in the case of c-pentaBDE;
- (b) ABS polymers used for casings of electrical and electronic equipment, in the case of c-octaBDE;
- (c) Solid wastes from the dismantling of electrical and electronic waste and the recycling of waste plastics;
- (d) Sludge and wastewater from municipal treatment plants; and
- (e) Landfill leachate.

20. POP-BDE wastes can be generated in a diverse range of applications, at different stages of the POP-BDEs life cycles 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 below provides an overview of relevant information on the life cycle of POP-BDE wastes.

Table 2: Overview of the production and application of POP-BDEs and their release media into the environment

Group	Source materials /Substances Used	Applications /Processes	End Product	Release Media
POP-BDEs CHEMICAL PRODUCTION				
Chemical Production	Diphenyl oxide, bromine	Chemical synthesis	POP-BDEs chemical	<ul style="list-style-type: none"> • Solid waste • Water • Sludge • Air
PRODUCTION OF ARTICLES CONTAINING POP-BDEs				
Plastic	Raw materials (acrylonitrile, butadiene, styrene, isocyanate, polyhydric alcohols, polystyrene, prolene, butanediol, terephthalate, hexamethylenediamine, adipic acid, etc.) POP-BDEs and other additives	Expansion and molding	Flame-retardant plastic: <ul style="list-style-type: none"> • ABS • PUR • HIPS • PP • PBT • PA 	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air
Building materials	PUR foam POP-BDEs and other additives	Expansion and molding	Board fireproofing: <ul style="list-style-type: none"> • Cold bridge insulation • Floors • Basement walls and foundations • Inverted roofs • Ceilings • Cavity insulation • Composite panels and laminates 	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air
Textile production	Flame-retarded textile (back-coating or fabrics)		Residential and commercial upholstered furniture	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air
			Transportation seating	
			Wall coverings and draperies	
			Protective clothing and other technical textiles	
Tents etc.				
Electric and electronic equipment	HIPS pellets	Production of casings for electronic and electric equipment	Electric and electronic appliances	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air
WASTE RECYCLING AND DISPOSAL				
Electrical and electronic waste dismantling	Electrical and electronic waste (Electrical and electronic plastic shells, circuit boards, wire and polyurethane foams, etc.)	Dismantling	Metals Plastic	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air

Waste plastic recycling	Waste plastic (Waste ABS, HIPS, PP, polyesters, polyamide, PBT, thermoplastic elastomer, polyolefins and other plastics)	Recycling	Plastic	<ul style="list-style-type: none"> • Solid waste • Landfill leachate • Liquid industrial and household cleaning waste • Wastewater • Sludge • Air
-------------------------	--	-----------	---------	---

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

21. 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”), and second, the waste must possess at least one of the characteristics listed in Annex III to the Convention (“List of hazardous characteristics”).

22. Annexes I and II to the Basel Convention list some of the wastes that may consist of, contain or be contaminated with POP-BDEs. These include:

- (a) Y18: Residues arising from industrial waste disposal operations;
- (b) Y40: Ethers;
- (c) Y45: Organohalogen compounds other than substances referred to in this Annex (e.g., Y39, Y41, Y42, Y43, Y44);
- (d) Y46: Wastes collected from households.

23. 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 after disposal of yielding a material which possess a hazardous characteristic), 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 papers for Annex III hazardous characteristics H11, H12 and H13 were adopted on an interim basis by the Conference of the Parties at its sixth and seventh meetings.

24. 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 [hazard characteristics] to demonstrate that a waste is not hazardous” (Annex I, paragraph (b)). List A of Annex VIII includes a number of wastes or waste categories which have the potential to contain or be contaminated with POP-BDEs, including:

- (a) A1180: Waste electrical and electronic assemblies or scrap 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, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B B1110);
- (b) A3080: Waste ethers not including those specified on list B;
- (c) A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics;
- (d) A4140: Waste consisting of or containing off specification or outdated chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics;
- (e) A4160: Spent activated carbon not included on list B (note the related entry on list B B2060).

25. List B of Annex IX includes wastes that “will not be wastes covered in 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 of Annex IX includes a number of wastes or waste categories which have the potential to contain or be contaminated with POP-BDEs, including:

- (a) B1110: Electrical and electronic assemblies:
 - Electronic assemblies consisting only of metals or alloys
 - Waste electrical and electronic assemblies or scrap² (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)
 - Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse and not for recycling or final disposal)
 - (b) B1250: Waste end-of-life motor vehicles, containing neither liquids nor other hazardous components;
 - (c) 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 to the related entry on list A A4160);
 - (d) B3010: Solid plastic waste;³
 - (e) B3030: Textile wastes;⁴
 - (f) B3035: Waste textile floor coverings, carpets;
 - (g) B3040: Rubber wastes

The following materials, provided they are not mixed with other wastes:

 - Waste and scrap of hard rubber (e.g., ebonite)
 - Other rubber wastes (excluding such wastes specified elsewhere);
 - (h) B3080: Waste parings and scrap of rubber.
26. For further information, see section II.A of the general technical guidelines.

B. Stockholm Convention

27. The present document covers intentionally produced POP-BDEs, whose production and use are to be eliminated in accordance with Article 3 and part I of Annex A to the Stockholm Convention.

28. Annex A, part III (“Definitions”), to the Stockholm Convention defines POP-BDEs 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.”

29. Annex A, part IV (“Hexabromodiphenyl ether and heptabromodiphenyl ether”), to the Convention outlines specific requirements for hexaBDE and heptaBDE, as follows:

² This entry does not include scrap from electrical power generation.

³ Refer to Annex IX to the Basel Convention for a full description of this entry.

⁴ *Ibid.*

“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.”

30. Annex A, part V (“Tetrabromodiphenyl ether and pentabromodiphenyl ether”), to the 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.”

31. Further information on the register of specific exemptions for POP-BDEs is available from: www.pops.int.

32. 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

33. The provisional definition of low POP content for POP-BDEs is 50 mg/kg or 1000 mg/kg as a sum of hexaBDE, heptaBDE, pentaBDE and tetraBDE.⁵

⁵ Determined in accordance with national or international methods and standards. In addition, a limit value has been set for the sum of tetra-, penta-, hexa-, and hepta-BDE because the commercial mixtures of those substances have varying congener composition (see subsection I.B.1 above) 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.

34. The low POP content described in the Stockholm Convention is independent from the provisions on hazardous waste under the Basel Convention.
35. Wastes with a content of POP-BDEs above 50 mg/kg or 1000 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 section IV.G.2. 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 section IV.G.3.
36. Wastes with a content of POP-BDEs at or below 50 mg/kg or 1000 mg/kg should be disposed of in accordance with the methods referred to in section IV.G.4 of the general technical guidelines (outlining disposal methods when POP content is low), taking into account section IV.I.1 below (pertinent to higher-risk situations).
37. For further information on low POP content, refer to section III.A of the general technical guidelines.

B. Levels of destruction and irreversible transformation

38. 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

39. See section IV.G below and section IV.G of the general technical guidelines.

IV. Guidance on environmentally sound management (ESM)

A. General considerations

40. For information, see section IV.A of the general technical guidelines.

B. Legislative and regulatory framework

41. Parties to the Basel and Stockholm conventions should examine their national strategies, policies, controls, standards and procedures to ensure that they are in agreement with of the two conventions and with their obligations under them, including those that pertain to ESM of POP-BDE wastes.
42. Elements of a regulatory framework applicable to POP-BDEs should include measures to prevent the generation of wastes and to ensure the environmentally sound management 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 on the production, sale, use, import and export of POP-BDEs;
 - (c) Recycling of articles containing POP-BDEs, in the case of parties that have registered for a specific exemption under the Stockholm Convention, set to expire at the latest in 2030;
 - (d) Transportation requirements for hazardous materials and waste;
 - (e) Specifications for containers, equipment, bulk containers and storage sites;
 - (f) Specification of acceptable analytical and sampling methods for POP-BDEs;
 - (g) Requirements for waste management and disposal facilities;
 - (h) Definitions of hazardous waste and conditions and criteria for the identification and classification of POP-BDE wastes as hazardous wastes;
 - (i) A general requirement for public notification and review of proposed waste-related government regulations, policies, certificates of approval, licences, inventory information and national releases and emissions data;
 - (j) Requirements for identification, assessment and remediation of contaminated sites;
 - (k) Requirements concerning the health and safety of workers; and
 - (l) Legislative measures on, e.g., waste prevention and minimization, inventory

development and emergency response.

43. Legislation should include a time limit for disposal of POP-BDEs including in products and articles, that have no clear phase-out dates so as to prevent the creation of stockpiles of such substances, products and articles.

44. For further information, see section IV.B of the general technical guidelines.

C. Waste prevention and minimization

45. Both the Basel and Stockholm conventions advocate waste prevention and minimization. Under the Stockholm Convention, the production and use of PDBEs is to be eliminated, with limited exemptions for their use as provided in part I of Annex A to the Convention.

46. Quantities of waste containing POP-BDEs should be minimized through isolation and source separation to prevent mixing and contamination of other waste streams.

47. The mixing and blending of wastes with POP-BDEs content above 50 mg/kg or 1000 mg/kg with other materials solely for the purpose of generating a mixture with a POP-BDEs content at or below 50 mg/kg or 1000 mg/kg 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.

48. For further information on waste prevention and minimization, see section IV.C of the general technical guidelines.

D. Identification of wastes

49. Article 6, paragraph 1 (a), of the Stockholm Convention requires each party to, *inter alia*, 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-BDE wastes is the starting point for their effective ESM.

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

1. Identification

51. POP-BDE wastes can be found in the following stages of the POP-BDEs lifecycles:

- (a) BDE manufacturing and processing:
 - (i) Waste generated from the production and processing of BDEs;
 - (ii) In 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 was disposed of;
 - (v) Stockpiles of unusable or unsellable material;
- (b) Industrial application of BDEs (PUR foams, plastics of electrical and electronic equipment, textiles):
 - (i) Residues generated from the application of BDEs;
 - (ii) In water, soil or sediment close to manufacturing or processing sites;
 - (iii) Industrial wastewater and sludge;
 - (iv) Landfill leachate from sites where waste from industrial application was disposed of;
 - (v) Stockpiles of unusable or unsellable products;
- (c) Use of products or articles containing BDEs:
 - (i) In water, soil or sediment close to sites where such products were used;
- (d) Disposal of products or articles containing BDEs:

- (i) In certain facilities for the collection, recycling and recovery of textiles, PUR foams and plastics of electronic and electrical equipment and vehicles;
- (ii) In municipal landfill leachate;
- (iii) In municipal wastewater and sludge.

52. 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 in identifying POP-BDEs.

2. Inventories

53. A national inventory should, as appropriate, include data on:

- (a) Production of POP-BDEs within a country;
- (b) Import and export of products and articles consisting of or containing POP-BDEs;
- (c) Disposal of POP-BDE waste; and
- (d) Import and export of POP-BDE waste.

54. 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., identifying relevant sectors that use or produce POP-BDEs);
- (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;
- (d) Step 4: managing and evaluating the data obtained in step 3 using an estimation method;
- (e) Step 5: preparing an inventory report; and
- (f) Step 6: periodically updating the inventory report.

55. For further information, please refer to the *Revised guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants* (UNEP, 2015c).

E. Sampling, analysis and monitoring

56. For general information on sampling, analysis and monitoring, see section IV.E of the general technical guidelines.

1. Sampling

57. Sampling serves as an important element for identifying and monitoring environmental concerns and human health risks.

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

59. Types of matrices that are typically sampled for POP-BDEs include:

- (a) Liquids:
 - (i) Leachate from dumpsites and landfills;
 - (ii) Water (surface water, drinking water and industrial effluents);
- (b) Solids:
 - (i) Stockpiles of products and formulations consisting of, containing or contaminated with POP-BDEs;
 - (ii) Solids from treatment or disposal processes (fly ash, bottom ash, sludge, still bottoms, other residues, clothing, etc.);

- (iii) Equipment, containers and other packaging materials (rinse or wipe samples), and tissues or fabrics used in the collection of wipe samples;
- (iv) Soil, sediment, rubble, sewage sludge and compost;
- (c) Gases:
 - (i) Air (indoor and outdoor);
 - (ii) Exhaust gas.

2. Analysis

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

61. The development and dissemination of reliable analytical methods and the accumulation of high-quality analytical data are important to understand the environmental impact of hazardous chemicals, including POPs.

62. 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 Environmental Protection Agency. X-ray fluorescence (XRF) and sliding spark analysis can be used as inexpensive and rapid screening methods to determine whether a material contains bromine. However, these methods will not serve to distinguish the types of chemicals that contain bromine. Table 3 presents 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
EPA Method 1614 A	Brominated Diphenyl Ethers in Water, Soil, Sediment, and Tissue by HRGC/HRMS
EPA Method 527	Determination of Selected Pesticides and Flame Retardants in Drinking Water by Solid Phase Extraction and Capillary Column Gas Chromatography/Mass Spectrometry (GC/MS)
EPA 8270D	Semi-volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)
IEC 62321-2008	Electrotechnical products – Determination of levels of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)
ISO 22032: 2009	Determination of selected polybrominated diphenyl ethers 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

3. Monitoring

63. Monitoring and surveillance serve as elements for identifying and tracking environmental concerns and human health risks. 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.

64. Monitoring programmes should be implemented in facilities managing POP-BDE wastes.

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

65. POP-BDE wastes should be handled, collected, packaged, labelled, transported and stored so as to prevent spills and leaks leading to worker exposure, releases to the environment or exposure of the community. The guidance on waste handling and collection contained herein may not apply to POP-BDE wastes that are consumer or household wastes, such as WEEE, since it has not been documented that such wastes pose significant risks to the environment or human health during handling and collection.

66. For further general information on handling, collection, packaging, labelling, transportation and storage, see section IV.F of the general technical guidelines.

1. Handling

67. POP-BDE wastes should be handled separately from other types of waste in order to prevent contamination of other waste streams.

68. Organizations handling POP-BDE wastes should have in place procedures for handling such wastes and workers should be trained in such procedures.

2. Collection

69. Collection arrangements and collection depots for POP-BDE wastes should provide for the separation of POP-BDE wastes from other wastes. In Europe, *Technical Specification (TS) 50625-3-1: Collection, logistics & treatment requirements for WEEE* is currently under development.

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

71. Waste plastics containing POP-BDEs from electrical and electronic wastes recycling facilities should be collected separately during dismantling process.

3. Packaging

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

(a) Packaging of solid POP-BDE wastes

73. The packaging of solid POP-BDE wastes can include corrugated cartons lined with protective anti-seepage plastic bags.

74. Special wooden pallets could be designed for use during storage to raise stored POP-BDE wastes above ground level and thereby protect them against moisture.

(b) Packaging of liquid POP-BDE wastes

75. PBDE-contaminated liquids can be packaged in special anti-seepage barrels.

(c) Packaging of POP-BDE contaminated soil

76. PBDE-contaminated soils can be packaged in triple layered, anti-leak, high-strength laminated bags.

4. Labelling

77. Every container carrying POP-BDE 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 (e.g., exact counts of equipment, weight, type of waste carried), the name of the site from which the waste originated so as to allow its 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.

5. Transportation

78. Appropriate measures should be taken to prevent scattering or leakage of POP-BDE wastes. Such wastes should be handled separately during transport to avoid their mixing with other materials.

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

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

6. Storage

81. POP-BDE 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.
82. Appropriate measures, such as the installation of partitions, should be taken to avoid contamination of the POP-BDEs wastes.
83. POP-BDE waste 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.
84. POP-BDE waste storage areas should have adequate access roads for vehicles. Simple roads can be constructed when necessary.
85. Storage sites should have structures to prevent underground leakage of POP-BDEs. 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 into the environment.

G. Environmentally sound disposal

1. Pre-treatment

86. Dismantling, disassembling and mechanical separation can be used to reduce the volume of POP-BDE wastes.
87. For information, see subsection IV.G.1 of the general technical guidelines.

2. Destruction and irreversible transformation methods

88. Destruction and irreversible transformation methods for the environmentally sound disposal of wastes with a POPs-BDE content above 50 mg/kg or 1000 mg/kg, according to the general technical guidelines, include at least:
 - (a) Cement kiln co-incineration;
 - (b) Hazardous waste incineration; and
 - (c) Thermal and metallurgical production of metals.
89. It should be noted that PBDDs/PBDFs can be generated from combustion and incineration of POP-BDE wastes.
90. For further information, see subsection IV.G.2 of the general technical guidelines.

3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option

91. For further information, see subsection IV.G.3 of the general technical guidelines.

4. Other disposal methods when the POP content is low

92. For information, see subsection IV.G.4 of the general technical guidelines.

H. Remediation of contaminated sites

93. For information, see section IV.H of the general technical guidelines.

I. Health and safety

94. For information, see section IV.I of the general technical guidelines.

1. Higher-risk situations

95. For general information, see subsection IV.I.1 of the general technical guidelines.
96. Higher-risk situations occur at sites where high concentrations of POP-BDEs or high volumes of POP-BDE wastes are found and a high potential for exposure of workers or the general population exists. Potential higher-risk situations specific to POP-BDEs may occur at:
 - (a) Sites of former POP-BDEs production;
 - (b) Sites at which electrical and electronic wastes are dismantled;

- (c) Sites at which waste plastic is recycled; and
- (d) Storage sites of POP-BDE wastes.

2. Lower-risk situations

97. For information on lower-risk situations, see subsection IV.I.2 of the general technical guidelines.

J. Emergency response

98. Emergency response plans should be in place for POP-BDEs in use, in storage, in transport or at disposal sites. Further information on emergency response plans is provided in section IV.J of the general technical guidelines.

K. Public participation

99. Parties to the Basel or Stockholm Convention should have open public participation processes. For further information see section IV.K of the general technical guidelines.

Annex to the technical guidelines

Bibliography

- Alcock, R.E. et al, 2003. "Understanding levels and trends of BDE - 47 in the UK and North America: an assessment of principal reservoirs and source inputs", *Environment International*, vol. 29, pp. 691-698.
- CEFIC, PlasticEurope, 2013. Best practice for the End-of-Life - EoL management of Polystyrene Foams in Building & Construction. Available from: www.plasticeurope.org.
- Environment Canada, 2013. *Consultation document. Proposed risk management measure for polybrominated diphenyl ethers (PBDEs)*. Available at: <http://www.ec.gc.ca/ese-ees/default.asp?lang=En&n=92B7DD05-1>.
- European Commission, 2006. *Reference Document Best Available Techniques for Waste Incineration*. Available from: <http://eippcb.jrc.ec.europa.eu/reference/wi.html>.
- Huang, Q.F., Yang, Y.F. and Wang, Q., 2012. "Potential for Serious Environmental Threats from Uncontrolled Co-processing of Wastes in Cement Kilns", *Environmental Science & Technology*, vol. 46 No. 24, pp. 13031–13032.
- ILO, 1999a. *Basics of Chemical Safety*. Available from: www.ilo.org.
- OECD, 2001. *Harmonised Integrated Classification System for Human Health and Environmental Hazards of Chemical Substances and Mixtures*. Available from: www.oecd.org.
- OECD, 2003. *Guiding Principles for Chemical Accident Prevention, Preparedness and Response, second edition*. Available from: www.oecd.org.
- OECD, 2004. *Recommendation of the Council on the Environmentally Sound Management (ESM) of Waste C(2004)100*. Adopted 9 June 2004. Available from: www.oecd.org.
- Persistent Organic Pollutants Review Committee (POPRC), 2008. *Risk Management Evaluation for Octabromodiphenyl ether*. UNEP/POPS/POPRC.4/15/Add.1.
- Stobiecki, S., J. et al, 2001. "Disposal of pesticides as an alternative fuel in cement kiln: project outline", in *6th International HCH & Pesticides Forum Book*, pp. 285-289. Available from: http://www.hchforum.com/6th/forum_book/.
- UNECE, 2003a. *Recommendations on the Transport of Dangerous Goods (Model Regulations)*. Available from: www.unece.org.
- UNECE, 2003b. *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. Available from: www.unece.org
- UNEP, 1993. *Storage of Hazardous Materials: A Technical Guide for Safe Warehousing of Hazardous Materials*. Available from: www.uneptie.org.
- UNEP, 1994. *Guidance Document on the Preparation of Technical Guidelines for the Environmentally Sound Management of Wastes Subject to the Basel Convention*. Available from: www.basel.int.
- UNEP, 1995a. *Model National Legislation on the Management of Hazardous Wastes and Other Wastes as well as on the Control of Transboundary Movements of Hazardous Wastes and Other Wastes and their Disposal*. Available from: www.basel.int.
- UNEP, 1995c. *Technical Guidelines on Incineration on Land (D10)*. Available from: www.basel.int.
- UNEP, 1995d. *Technical Guidelines on Specially Engineered Landfill (D5)*. Available from: www.basel.int.
- UNEP, 2003. *Interim guidance for developing a national implementation plan for the Stockholm Convention*. Available from: www.pops.int.
- UNEP, 2004a. *Guidance for a Global Monitoring Programme for Persistent Organic Pollutants*. 1st edition, June 2004. Available at: www.chem.unep.ch/gmn/GuidanceGPM.pdf.
- UNEP, 2004b. *Review of the Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries*. Available from: www.unep.org/stapgef.

- UNEP 2005. *UNEP/GEF project on existing capacity and capacity building needs for analyzing pops in developing countries*. Available from: www.chem.unep.ch/pops/laboratory/default.htm.
- UNEP, 2006b. *Draft Guidance for Analysis of Persistent Organic Pollutants (POPs)*. Available from: www.chem.unep.ch/pops/laboratory/default.htm.
- UNEP, 2007. *Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on persistent organic pollutants*. Available from: <http://chm.pops.int/Implementation/BATandBEP/Guidance/tabid/3636/Default.aspx>
- UNEP, 2015. *General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants*.
- UNEP, 2015a. *Basel Convention: Manual for Implementation*. Available from: www.basel.int.
- UNEP, 2015b. *Basel Convention: Guide to the Control System*. Available from: www.basel.int.
- UNEP, 2015c. *Revised guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants*. Available from: chm.pops.int
- UNEP, 2015d. *Revised guidance on best available techniques and best environmental practices for the recycling and disposal of articles containing polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants*. Available from: chm.pops.int.
- UNEP, 2015e. *Methodological guide for the development of inventories of hazardous wastes and other wastes under the Basel Convention*. Available from: www.basel.int.
- UNEP, different dates. *Basel Convention Technical Guidelines*. Available from: www.basel.int.
- UNEP, 2012. *Labelling of products or articles that contain POPs: Initial considerations*. Available from: chm.pops.int.
- UNEP, 2010. *Practices in the Sound Management of Chemicals*. Available from: chm.pops.int.
- UNEP, 2002. *Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal*. Available from: www.basel.int.
- UNEP, 2012. *Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns*. Available from: www.basel.int.
- Error! Hyperlink reference not valid.** WHO, 1995. *Global Strategy on Occupational Health for All: The Way to Health at Work*. Available from: www.who.int.
- Yang, Y.F. et al., 2012. "Deca-Brominated Diphenyl Ether Destruction and PBDD/F and PCDD/F Emissions from Coprocessing deca-BDE Mixture- Contaminated Soils in Cement Kilns" *Environmental Science & Technology*, vol. 46 No. 24, pages 13409–13416.
-