



Distr.: General

13 May 2016

English only

**Open-ended Working Group of the Basel Convention
on the Control of Transboundary Movements of
Hazardous Wastes and Their Disposal
Tenth meeting**

Nairobi, 30 May–2 June 2016

Item 3 (b) (i) a. of the provisional agenda*

**Matters related to the work programme of the
Open-ended Working Group for 2016–2017:
scientific and technical matters: technical guidelines:
technical guidelines on the environmentally sound
management of wastes consisting of, containing or
contaminated with persistent organic pollutants**

**Draft technical guidelines on the environmentally sound management
of wastes consisting of, containing or contaminated with
hexachlorobutadiene**

Note by the Secretariat

As referred to in the note by the Secretariat on technical guidelines (UNEP/CHW/OEWG.10/5), the small intersessional working group on persistent organic pollutant wastes prepared the draft technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene, as set out in the annex to the present note. The present note, including its annex, has not been formally edited.

* UNEP/CHW/OEWG.10/1.

Annex

**Draft technical guidelines on the environmentally sound
management of wastes consisting of, containing or contaminated
with hexachlorobutadiene**

(Draft of 3 May 2016)

Contents

Abbreviations and acronyms	4
Units of measurement	4
I. Introduction	5
A. Scope	5
B. Description, production, use and wastes	5
1. Description	5
2. Production	6
3. Use	7
4. Wastes	7
II. Relevant provisions of the Basel and Stockholm conventions.....	11
A. Basel Convention	11
B. Stockholm Convention	12
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	12
C. Methods that constitute environmentally sound disposal	12
IV. Guidance on environmentally sound management (ESM).....	13
A. General considerations	13
B. Legislative and regulatory framework	13
C. Waste prevention and minimization	13
D. Identification of wastes	14
1. Identification	14
2. Inventories	14
E. Sampling, analysis and monitoring	15
1. Sampling	15
2. Analysis	15
3. Monitoring	16
F. Handling, collection, packaging, labelling, transportation and storage	16
1. Handling	16
2. Collection	16
3. Packaging	16
4. Labelling	16
5. Transportation	16
6. Storage	16
G. Environmentally sound disposal	17
1. Pre-treatment	17
2. Destruction and irreversible transformation methods	17
3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option	17
4. Other disposal methods when the POP content is low	17
H. Remediation of contaminated sites	17
I. Health and safety	17
1. Higher-risk situations	17
2. Lower-risk situations	17
J. Emergency response	17
K. Public participation	17
Annex: Bibliography.....	18

Abbreviations and acronyms

APHA	American Public Health Association
BAT	best available techniques
BEP	best environmental practices
BREF	best available techniques reference document
CAS	Chemical Abstracts Service
EPA	United States Environment Protection Agency
ESM	environmentally sound management
EU	European Union
LVOC	large volume organic chemicals
NIOSH	National Institute for Occupational Safety and Health
PBBs	polybrominated biphenyls
PCBs	polychlorinated biphenyls
PCTs	polychlorinated terphenyls
PCDD(s)	polychlorinated dibenzo-p-dioxin(s)
PCDF(s)	polychlorinated dibenzo-furan(s)
POP	persistent organic pollutant
UNEP	United Nations Environment Programme
WEEE	waste electrical and electronic equipment

Units of measurement

µg/l	microgram(s) per liter. Corresponds to parts per billion
µg/kg	microgram(s) per kilogram. Corresponds to parts per billion by mass
mg/kg	milligram(s) per kilogram. Corresponds to parts per million by mass

I. Introduction

A. Scope

1. The present technical guidelines provide guidance on the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with hexachlorobutadiene (HCBd), pursuant to several decisions adopted by the bodies of two multilateral environmental agreements on chemicals and wastes.¹
2. HCBd was listed in Annex A to the Stockholm Convention in 2015, through an amendment that entered in force in 2016. The current guidelines address all activities pertaining to waste management, including unintentionally produced HCBd. It should be noted that unintentionally produced HCBd, however, is currently not subject to Stockholm Convention provisions.
3. The present technical guidelines should be used in conjunction with the General technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants) (UNEP, [...]) (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 POPs for purposes of their identification and management.
4. In addition, the use of HCBd as a pesticide will be addressed in more detail in the [future update of] Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with the pesticides aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dieldrin, endrin, heptachlor, hexachlorobenzene, [hexachlorobutadiene,] lindane, mirex, pentachlorobenzene, [pentachlorophenol,] perfluorooctane sulfonic acid, technical endosulfan and its related isomers or toxaphene or with hexachlorobenzene as an industrial chemical (UNEP, [...]).

B. Description, production, use and wastes

1. Description

5. HCBd (CAS No: 87-68-3) is a halogenated aliphatic compound (Figure 1). It is a colorless liquid with a mild odor. HCBd is insoluble in water and denser than water. It is not very volatile or flammable (ATSDR, 1994). Synonyms for HCBd include perchlorobutadiene; 1,1,2,3,4,4-hexachloro-1,3-butadiene; 1,3-hexachlorobutadiene (USEPA, 2003).

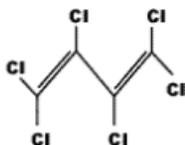


Figure 1: Structural formula of HCBd

6. HCBd is detected in abiotic and biotic media, even in remote areas such as the Arctic (Hung, 2012). HCBd was found in surface waters, drinking water, ambient air, aquatic and terrestrial organisms (Lee et al., 2000, Kaj & Palm, 2004, Lecloux, 2004). HCBd levels in water and fish from European rivers (Rhine, Elbe) have decreased significantly over the last decades (RIWA, 2004). Due to the scarcity of data it is difficult to identify a temporal trend for remote areas. Although recent (i.e. within the past 15 years) data on biota are very infrequent, HCBd contamination has been reported for beluga blubber in 2003 (of up to 278 µg/kg lipid weight) and for polar bear fat (1–9 µg/kg wet weight) from 2002. Based on the available evidence, HCBd is persistent, bioaccumulative and very toxic to aquatic organisms and toxic to birds. (UNEP/POPs/POPRC.8/16/Add.2)

¹ Decision BC-12/3 and BC-13/[...] of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; decision OEWG-10/[...] the Open-ended Working Group of the Basel Convention; and decision SC-7/12 of the Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants.

7. HCBd bioaccumulates strongly in rice and vegetables (Tang et al, 2014). In mid-1970's levels of HCBd in beverages, bread, butter, cheese, eggs, fruits, meats, milk, oils and potatoes ranging from non-detectable to 3.7 µg/kg (grapes) in the United Kingdom. High concentrations were found in eels from the river Rhine in 1993 (average concentration 55 µg/kg). In the 1970's concentrations around 1 mg/kg were found in fish in a lake fed by the river Rhine in Holland. (cited in Jürgens et al., 2013). Concentrations of HCBd in chicken, eggs, fish, margarine, meat and milk ranged from non-detectable to 42 µg/kg (egg yolk) in Germany (Environment Canada 2000).

2. Production

8. HCBd is not known to be currently intentionally produced in Europe, Japan, the United States or Canada. The commercial production in Europe stopped in the late 1970's and in Japan in the 1980's. Reported common trade names were Dolen-Pur; C-46, UN2279 and GP-40-66:120 (Lecloux, 2004). HCBd has never been manufactured as a commercial product in the United States or Canada, (USEPA, 2003, van der Honing, 2007, Canada, 2013). However, possible remaining intentional production (particularly in quantities below the limits for high-production volumes) in other regions cannot be excluded (UNEP/POPS/POPRC.9/13/Add.2). There are no natural sources of HCBd in the environment (Environment Canada 2000).

9. Intentional production of HCBd is already prohibited in Canada, the EU, Mexico, and possible only under authorization in Japan (UNEP/POPS/POPRC.9/13/Add.2).

10. HCBd is primarily generated as an unintentional by-product during the manufacture of chlorinated chemicals, e.g. chlorinated hydrocarbons, particularly of perchloroethylene and trichloroethylene, and carbon tetrachloride (Table 1, Lecloux, 2004, UNEP/POPS/POPRC.9/13/Add.2). It can also be formed during the production of vinyl chloride, allyl chloride and epichlorohydrin, although this is reported as unlikely from a technological point of view, according to a dossier prepared for the European chloralkali industry (Lecloux, 2004). HCBd as a by-product has been partly sold for commercial uses (UNEP/POPS/POPRC.9/13/Add.2).

11. Information on unintentional HCBd production is scarce. High volumes were produced as by-product of during the 1970s and 1980s. The worldwide by-production of HCBd in heavy fractions was estimated at 10 000 tonnes in 1982 (Lecloux, 2004). In the United States alone, the estimated annual HCBd waste generation was 3,600 tonnes in 1975, and 12,000 tonnes in 1982 (USEPA, 2003).

12. The reported European by-production volumes were in the same range as in North America. In the European Union in 1980 (EU-10), about 10,000 tonnes of HCBd were generated. In Germany, 4,500 t/year of HCBd was produced during the low-pressure chlorolysis for combined production of perchloroethylene and tetrachloromethane in 1979 (UBA, 2015)). In early 1990's the total amount in Germany was estimated at 550 – 1,400 t/year, whereof the remaining quantity was directed back into the production process. (UBA, 2015). In 1990, in Western Europe, a HCBd quantity of 2,000 to 49,900 tonnes was estimated (BUA 1991 as cited in UNEP/POPS/POPRC.9/13/Add.2; original reference in German not available).

13. Processes relevant for the unintentional production of HCBd are shown in Table 1. Many countries have introduced requirements to reduce unintentional production e.g. via use of best available technologies (BAT) (UNEP/POPS/POPRC.9/13/Add.2). Chlorinated solvents are produced in many countries in the world in large quantities.

Table 1. Processes relevant for the unintentional production of HCBd according to BUA (1991) (UNEP/POPS/POPRC.9/13/Add.2).

Process	HCBd concentration in the raw product	Remarks
Low pressure chlorolysis for the manufacturing of perchloroethylene and carbon tetrachloride	5% (50 000 ppm)	HCBd is recycled in the process together with other high-boiling by-products
Optimised low pressure chlorolysis for the manufacturing of perchloroethylene and carbon tetrachloride	0.2 to 0.5% (2000 to 5000 ppm)	The HCBd containing residue is treated by distillation which results in a residue containing 7 to 10% HCBd (70 000-100 000 ppm). The latter residue is incinerated.
Manufacturing of hexachlorocyclopentadiene	0.2 to 1.11 % (2000 to 11 100 ppm)	

Manufacturing of tetrachloride and trichloroethylene from acetylene and chlorine and subsequent decomposition to carbon tetrachloride and trichloroethylene	0.4% (4000 ppm)	
---	--------------------	--

14. Other sources of unintentional formation of HCBd are the manufacture of magnesium (Deutscher & Cathro, 2000). HCBd can also be formed unintentionally during incineration processes (e.g. motor vehicle emissions, incineration processes of acetylene, incineration of chlorine residues) and can be contained in residues from waste incineration (UNEP/POPS/POPRC.9/13/Add.2, UBA, 2015).

15. Parties to the Stockholm Convention must prohibit and/or eliminate the production of HCBd. Decision on listing HCBd in Annex C of the Stockholm Convention is pending.

3. Use

16. There is no information on on-going uses of HCBd. In the past HCBd has been applied e.g. as a solvent (for rubber, elastomers and other polymers, for carbon-tetrachloride (C4) and higher hydrocarbons), intermediate in production of fluor-containing lubricants, a “scrubber” to recover chlorine-containing gas or to remove volatile organic components from gas, hydraulic fluid, heat transfer liquid (in combination with trichloroethene) or a non-flammable insulating liquid in transformers, fluid in gyroscopes, in the production of aluminium and graphite rods, and as a plant protection product. There is no specific information available on any existing applications of HCBd and all applications seem to have ceased, but cannot be fully excluded. (Environment Canada, 2000, UNEP/POPS/POPRC.9/13/Add.2, UBA, 2015).

17. Prior to 1975 the largest use of HCBd in the USA – and probably also outside the USA – was for the recovery of “snift” (chlorine containing gas in chlorine plants). HCBd is no longer used for this process, however (ATSDR, 1994). HCBd was mainly used as a chemical intermediate in the manufacture of rubber compounds and that lesser quantities were used as solvent, fluid for gyroscopes, heat transfer liquid, hydraulic fluid, chemical intermediate in the production of chlorofluorocarbons and lubricants, laboratory reagent (ATSDR, 1994). In Canada HCBd is no longer used as a solvent (Environment and Health Canada, 2000).

18. HCBd was used as a seed-dressing fungicide or insecticide in vineyards in the former Soviet Union (application rate of 100-350 kg/ha), and in Mediterranean European countries and in Argentina (Lecloux, 2004, UNECE, 2007, UBA, 2015). In France the fumigant use was extensive and discontinued in 2003 (ESWI, 2011). It is unclear whether HCBd is still used as a plant protection product anywhere.

19. A method to synthesize graphite sheets by dechlorination of HCBd with sodium has been developed. Graphite flakes are used as electronically conducting fillers in the production of conducting polymer composites in various fields such as fuel cell electrodes, corrosion resistant materials, batteries etc. (Shi et al., 2004). However, there is no information on whether this method involving HCBd is applied anywhere.

20. Parties to the Stockholm Convention shall prohibit and/or eliminate the use of HCBd. The use of unintentionally produced by-product HCBd is also prohibited.

4. Wastes

21. 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 HCBd from waste management activities. In that context, the following should be recognized:

(a) The uses of HCBd have apparently ceased, although there are uncertainties related to plant protection use in the former Soviet Union;

(b) Some of the HCBd applications have a long service-life and despite the uses being ceased, HCBd may still enter the waste management stage (e.g. hydraulic, heat transfer or transformer fluids). However, in a recent study by UBA (2015), HCBd was not found relevant in any waste streams in Germany;

(c) Unintentional production from chemical production is believed to be the major source

of HCBd. In 2000, 15,000 tonnes HCBd was produced as by-product (Lecloux, 2004). Waste streams resulting from production of HCBd as a by-product of certain chlorinated hydrocarbons have been reported to contain 33-80% HCBd (ATSDR, 1994). Furthermore, in modern production processes the residues are incinerated in high temperature or recycled back into the process. In the United States, most of the disposal waste from chlorinated hydrocarbon manufacturing processes is incinerated (Lecloux, 2004). In Germany, no detectable HCBd residues were found in the slag (UBA, 2015). In the United States, soil concentration of up to 980 mg/kg were found at chemicals industry sites (Li et al., 1976). UBA (2015) reports measurements of sewage sludge from municipal waste-water (0.01 mg/kg) as well as on 22 measurements of sewage sludge from a treatment of industrial waste-water (average 0.193 mg/kg);

(d) Unintentionally produced HCBd has been placed on the commercial market replacing intentional production;

(e) Sites where HCBd fumigants have been used may be highly contaminated. Soils in vineyards infected with Phylloxera were treated with 250 kg/ha HCBd, were contaminated to the level of 7.3 mg/l after 8 months and 3 mg/kg after 32 months (Vorobyeva (1980) in IPCS (1994) – the original reference is only available in Russian);

(f) Historical landfilling of heavy fractions from the production of chlorinated organic substances can also lead to secondary HCBd emissions or leachates to water and soil via sewage sludge (ASDTR, 1994, Staples, 2003, Lecloux, 2004, ESWI, 2011). There is no insight into the total amount of waste sites worldwide, nor on their releases (UNEP/POPS/POPRC.9/13/Add.2). Individual information on HCBd contents in sewage sludge is available for China (average 39 µg/kg dry matter; Cai et al. 2007) and the United States (0.6 µg/kg; IPCS 1994). In sediments the highest concentrations reported were 430 mg/kg in sediment near hotspots (ESWI, 2011). Krantzberg et al. (1999) estimated the HCBd bound in contaminated sediment in the Great Lakes region at 400 kg. In a study on municipal solid waste landfill leachates in Poland, HCBd was found in 10 out of 22 leachate samples highest concentration being 0.084 µg/l (Matejczyk et al., 2011);

(g) HCBd is suspected to be developed under similar incineration conditions like dioxins and furans (PCDD/PCDF), thus it can occur during waste incineration (e.g. incineration of municipal waste, clinical waste and hazardous waste) and might enter the waste stream through incineration residues (ashes and slag). HCBd is not a standard parameter for the analysis of solid residues. Specific measured values are not available and it remains unclear whether relevant amounts of HCBd occur in waste. (UBA, 2015);

(h) HCBd can still be present in rubber compounds in marginal amounts according to the national association on rubber and polymers in France (Syndicat National du Caoutchouc et des Polymères according to UBA, 2015). However, there is no further information on possible HCBd residues when used as a chemical intermediate in rubber, elastomer, or lubricant production.

22. HCBd releases can arise from the disposal of old HCBd-containing products. Concentration of HCBd in waste depends on the quantities in which HCBd was originally present in specific products and the quantities released during product use and waste management. There is very little information on HCBd concentrations in any articles. In a study by UBA (2015), no HCBd waste streams of significance could be identified in Germany. However, based on the known uses wastes consisting of, containing or contaminated with HCBd (hereinafter referred to as “HCBd wastes”) may potentially be found in:

- (a) HCBd chemical, including production waste from chemical processes;
- (b) Sludge from industrial sewage treatment;
- (c) Contaminated sediments;
- (d) Transformers;
- (d) Heat exchangers;
- (e) Hydraulic fluids;
- (f) Waste electrical and electronic equipment (WEEE);
- (g) Agricultural insecticides and fungicides.

23. The most important HCBd waste streams in terms of potential volume are expected to be:

- (a) Soils and sediments contaminated from substandard HCBd disposal;
- (b) HCBd production waste;

- (c) Obsolete insecticides and fungicides;
 - (d) Transformer fluids;
 - (e) Heat exchanging fluids.
24. The most important HCBD waste streams in terms of potential releases or concentration of HCBD are expected to be:
- (a) HCBD production waste, including waste disposed of in the past and waste water treatment sewage sludge;
 - (b) Obsolete HCBD insecticide and fungicide waste;
 - (c) Transformer, heat exchange and hydraulic fluids.
25. HCBD wastes can be generated in a diverse range of applications, at different stages of the life cycle and through different release media. Knowledge of release media guides the analysis and choice of methods that may be used to manage such wastes. Many of these applications are assumed to have been phased out. Table 2 provides an overview of relevant information regarding the life cycle of HCBD wastes.

Table 2: Overview of the production and application of HCBd and their release media into the environment (Based on UNECE, 2007, UNEP/POPS/POPRC.8/16/Add.2 and UNEP/POPS/POPRC.9/13/Add.2).

Group	Source materials /Substance used	Applications /Processes	End Product	Release Media
HCBd PRODUCTION				
Chemical Production	Chlorine, hexyl iodide (original intentional production process)	Chemical synthesis	HCBd	Solid waste Liquid waste Sludge Air
		Production of chlorinated hydrocarbons, particularly perchloroethylene, trichloroethylene and carbon tetrachloride	Chlorinated hydrocarbons (e.g. tetrachloromethane, Halon 104, Freon 10 etc.), residual HCBd	
		Low-pressure chlorolysis for the production of tetrachloroethene and tetrachloromethane	0.2-0.5% HCBd in the raw product. The residue finally obtained from the process contains after distillation 7-10% HCBd	
	Acetylene, chlorine	Production of 1,1,2,2-tetrachloroethane (no longer used according to UNECE, 2007)	0.4% HCBd	
Production of articles containing HCBd				
Processes where HCBd is used	HCBd + unknown	Production of transformer fluids	Transformer fluids	Solid waste Landfill leachate Wastewater cleaning Sludge Air
	HCBd + unknown	Production of heat exchange fluids	Heat exchange fluids	
	HCBd + unknown	Production of fluor-containing hydraulic fluids	Hydraulic fluids (HCBd residues unknown)	
	Unknown	Solvent in production of rubber and elastomers	HCBd residues unknown	
	HCBd + unknown	Production of HCBd plant protection products	HCBd insecticides and fungicides	
USE OF PRODUCTS AND ARTICLES CONTAINING HCBd (The boxes below include articles that have become wastes. Such wastes may also be generated at production sites)				
Electric and electronic equipment	Transformer fluids		Transformer fluid waste, contaminated transformers	Solid waste Landfill leachate Liquid industrial waste Wastewater Sludge Air
	Hydraulic fluids		Hydraulic fluid waste, contaminated hydraulic equipment	
	Gyroscopes		Gyroscope fluid waste, contaminated equipment	
Agricultural chemicals	Agricultural insecticides and fungicides		Obsolete pesticide waste	

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

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

27. Annex I lists some of the wastes which may consist of, contain or be contaminated with HCBd:

- (a) Y4: Wastes from the production, formulation and use of biocides and phytopharmaceuticals;
- (b) Y6: Wastes from the production, formulation and use of organic solvents;
- (c) Y9: Waste oils/water, hydrocarbons/water mixtures, emulsions;
- (d) Y10: Waste substances and articles containing or contaminated with polychlorinated biphenyls (PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs);
- (e) Y18: Residues arising from industrial waste disposal operations;
- (f) Y41: Halogenated organic solvents.

28. Annex I wastes are presumed to exhibit one or more Annex III hazard characteristics, which may include H6.1 “Poisonous (acute)”, H8 “Corrosive”, 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 these characteristics. National tests may be useful for identifying a particular hazard characteristic in Annex III of the Convention 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 to the Basel Convention at its sixth and seventh meeting.

29. List A of Annex VIII of the Convention describes wastes that are “characterized as hazardous under article 1, paragraph 1 (a), of this Convention.” However, “[d]esignation of a waste on Annex VIII does not preclude, in a particular case, the use of Annex III [List of hazardous 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 that have the potential to contain or be contaminated with HCBd, 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) A3040: Waste thermal (heat transfer) fluids;
- (c) A3160: Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations;
- (d) A3170: Wastes arising from the production of aliphatic halogenated hydrocarbons (such as chloromethane, dichloro-ethane, vinyl chloride, vinylidene chloride, allyl chloride and epichlorhydrin);
- (e) A4030: Wastes from the production, formulation and use of biocides and phytopharmaceuticals, including waste pesticides and herbicides which are off-specification, outdated or unfit for their originally intended use;
- (f) A4060: Waste oils/water, hydrocarbons/water mixtures, emulsions;
- (g) A4100: Wastes from industrial pollution control devices for cleaning of industrial off-gases but excluding such wastes specified on list B;
- (h) A4130: Waste packages and containers containing Annex I substances in

concentrations sufficient to exhibit Annex III hazard characteristics;

(i) A4140: Waste consisting of or containing of specification or outdated chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics;

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

30. List B of Annex IX lists wastes that will not be wastes covered by Article 1, paragraph 1 (a), 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 that have the potential to contain or be contaminated with HCBd, including:

(a) B1040: Scrap assemblies from electrical power generation not contaminated with lubricating oil, PCB or PCT to an extent to render them hazardous;

(b) 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).

31. For further information, see section II.A of the general technical guidelines.

B. Stockholm Convention

32. The present guidelines cover intentionally-produced HCBd, whose production and use are to be eliminated in accordance with Article 3 and part I of Annex A to the Stockholm Convention.

33. 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

34. The provisional definition of low POP content for HCBd is [] mg/kg.²

35. The low POP content described in the Stockholm Convention is independent from the provisions on hazardous waste under the Basel Convention.

36. Wastes with a content of HCBd above [] 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. Otherwise, they may 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.

37. Wastes with a content of HCBd at or below [] 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 methods when POP content is low), taking into account section IV.I.1 below (pertinent to high-risk situations).

38. For further information on low POP content, refer to section III.A of the general technical guidelines.

B. Levels of destruction and irreversible transformation

39. 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

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

² Determined according to national or international methods and standards.

IV. Guidance on environmentally sound management (ESM)

A. General considerations

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

B. Legislative and regulatory framework

42. 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 the two conventions and their obligations under them, including those that pertain to ESM of HCBd wastes.

43. Elements of a regulatory framework applicable to HCBd 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 on the production, sale, use, import and export of HCBd;
- (c) A requirement that BAT and best environmental practices (BEP) be employed in the unintentional production and use of HCBd. Relevant BAT is specified e.g. in the BREF Document on production of Large Volume Organic Chemicals (EC BREF LVOC, 2003 (currently being updated) and Section VI.B Part III Chapter 4 of the UNEP BAT and BEP guidelines (UNEP, 2007);
- (d) Measures to ensure that HCBd wastes cannot be disposed of in ways that may lead to recovery, recycling, reclamation, direct reuse or alternative uses of HCBd;
- (e) Adequate ESM controls to separate HCBd-containing materials from materials that can be recycled (e.g., non-HCBd containing hydraulic fluids);
- (f) Transportation requirements for hazardous materials and waste;
- (g) Specifications for containers, equipment, bulk containers and storage sites for HCBd wastes;
- (h) Specification of acceptable analytical and sampling methods for HCBd;
- (i) Requirements for waste management and disposal facilities;
- (j) Definitions of hazardous waste and conditions and criteria for the identification and classification of HCBd 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; and
- (n) Legislative measures on, e.g., waste prevention and minimization, inventory development and emergency response.

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. The production and use of HCBd are to be eliminated under the Stockholm Convention.

46. Quantities of waste containing HCBd should be minimized through isolation and separation of those wastes from other wastes at source in order to prevent their mixing with, and contamination of, other waste streams.

47. The mixing and blending of wastes with HCBd content above [] mg/kg with other materials solely for the purpose of generating a mixture with an HCBd content at or below [] 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, see section IV.C on waste prevention and minimization 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 HCBd 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. HCBd wastes can be found in the following stages of the HCBd life cycle:

- (a) HCBd manufacturing and processing:
 - (i) Waste generated from the production and processing of HCBd;
 - (ii) In water, soil or sediment close to manufacturing, processing sites;
 - (iii) Industrial wastewater and sludge;
 - (iv) Landfill leachate where chemical manufacturing or processing waste was disposed of;
 - (v) Stockpiles of unusable or unsellable material;
- (b) Industrial applications of HCBd (production of rubber and elastomers, manufacture of transformer, heat exchange, and hydraulic fluids, use as a chemical in chlorine capture):
 - (i) Residues generated from the application of HCBd;
 - (ii) In water, soil or sediments close to manufacturing or processing sites;
 - (iii) Industrial wastewater and sludge;
 - (iv) Landfill leachate where waste from industrial applications was disposed of;
 - (v) Stockpiles of unusable or unsellable products;
- (c) Use of products or articles containing HCBd (e.g. HCBd insecticides and fungicides, transformers, hydraulic systems, gyroscopes):
 - (i) In water, soil or sediments close to sites where such products were used;
- (d) Disposal of products or articles containing HCBd:
 - (i) In certain facilities for the collection, recycling and recovery of electronic and electrical equipment, and;
 - (ii) In municipal and industrial landfill leachate;
 - (iii) In municipal and industrial 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 articles and mixtures containing HCBd. It is believed, however, that intentional use of HCBd has ceased.

2. Inventories

53. When developing HCBd inventories, it is important to consider the service lives of HCBd-containing articles and the timing of their placement on the market. While there have been diverse industrial uses for HCBd, it appears that it is not present in consumer articles, excluding agricultural pesticides. In addition, several industrial uses have been phased out at least 10-20 years ago.

54. The first step that should be taken when developing HCBd inventories is the identification of the types of industries that may have been producing HCBd or using it in the production of e.g. rubbers, elastomers, hydraulic and transformer fluids or agricultural pesticides. Inventories should, as appropriate, be based on information on:

- (a) Production of HCBd within a country;

- (b) Industrial use of HCBD;
- (b) Imports and exports of products and articles containing HCBD;
- (c) Use of products and articles containing HCBD in the country;
- (d) Current and past regulatory requirements e.g. regarding electronic equipment, transformer and hydraulic fluids;
- (e) Disposal of HCBD wastes, including incineration;
- (f) Imports and exports of HCBD wastes.

55. The preparation of inventories requires cooperation between those producing the inventories and relevant actors, such as the industry producing chlorine solvents; electricity companies; rubber and elastomer producers; customs officials; agricultural experts; personnel at waste disposal and recycling facilities; and national focal points under the Basel and Stockholm Conventions. In some cases, government regulations may be required to ensure those who hold HCBD wastes report their holdings and cooperate with government inspectors.

56. Although it appears that HCBD is no longer intentionally produced, there may be intentional use due to unintentional production. It is also possible that obsolete products and articles with long service-life may still be entering the waste stage.

E. Sampling, analysis and monitoring

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

58. Sampling, analysis and monitoring procedures should be established for articles that may contain HCBD.

1. Sampling

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

60. 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. Documented sampling methods exist for HCBD in air (NIOSH Method 2543).

61. Types of matrices that are typically sampled for HCBD include:

- (a) Liquids:
 - (i) Leachate from dumpsites and landfills;
 - (ii) Water (surface water and groundwater, drinking water, and industrial and municipal effluents);
 - (iii) Biological fluids (blood, in the case of worker health monitoring);
- (b) Solids:
 - (i) Sewage sludge;
 - (ii) Biological samples (adipose tissue);
 - (iii) Stockpiles of mixtures and articles consisting of, containing or contaminated with HCBD;
- (c) Gases:
 - (i) Air (indoor and outdoor);
 - (ii) Exhaust gas.

2. Analysis

62. Analysis refers to the extraction, purification, separation, identification, quantification and reporting of HCBD 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.

63. 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.

64. Methods to analyze HCBd with gas chromatography with electron-capture (GC-ECD) as well as gas chromatography with/mass spectrometer (GC-MS) have been developed for at least fish, vegetable, eggs, milk extracts, wastewater and soils (e.g. EPA Method 612, APHA Method 6410B, APHA Method 6200B) (HSDB 2016, Majoros et al., 2013). EPA Methods 612 and 625 can be used for analysis of HCBd in industrial and municipal wastewater.

3. Monitoring

65. 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.

66. Monitoring programmes should be implemented in facilities managing HCBd and HCBd wastes and on sites that have been contaminated by HCBd (e.g. water bodies, landfills and dumpsites).

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

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

1. Handling

68. Organizations handling HCBd wastes should have in place a set of procedures for handling such wastes and workers should be trained in such procedures.

2. Collection

69. Collection arrangements that include depots for HCBd wastes should provide for the separation of HCBd wastes from other wastes.

70. Collections depots should not become long-term storage facilities for HCBd wastes.

3. Packaging

71. In cases where HCBd wastes are considered hazardous wastes, they should be properly packaged before storage in accordance with the applicable provisions of national legislation.

4. Labelling

72. In cases where HCBd wastes are considered hazardous wastes, every container carrying HCBd waste should be clearly labelled with a hazard warning label and a label providing details of the container and a unique serial number. Such details should include container contents (e.g., exact counts of equipment, volume, weight, type of waste carried), the name of the site from which the waste originated so as to allow its traceability, the date of any repackaging and the name and telephone number of the person responsible for the repackaging operation.

5. Transportation

73. In cases where HCBd wastes are considered hazardous wastes, they should be transported in accordance with applicable provisions of national legislation.

6. Storage

74. HCBd wastes should be stored in designated sites and appropriate measures should be taken to prevent the scattering, release and underground seepage of HCBd, and to control the spread of odors.

75. Appropriate measures, such as the installation of partitions, should be taken to avoid contamination of other materials and wastes with HCBd.

76. Storage areas for HCBd wastes should have adequate access roads for vehicles.

77. Large amounts of HCBd wastes in storage should be protected from fire.

G. Environmentally sound disposal**1. Pre-treatment**

78. For information, see subsection IV.G.1 of the general technical guidelines.

2. Destruction and irreversible transformation methods

79. Destruction and irreversible transformation methods for the environmentally sound disposal of wastes with an HCBd content above [] mg/kg include, according to the general technical guidelines, at least:

- (a) [Cement kiln co-incineration;]
- (b) [Hazardous waste incineration;]

80. 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

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

4. Other disposal methods when the POP content is low

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

H. Remediation of contaminated sites

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

I. Health and safety

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

1. Higher-risk situations

85. For general information, see subsection IV.I.1 of the general technical guidelines.

86. Higher-risk situations occur at sites where high concentrations of HCBd or high volumes of HCBd wastes are found and a high potential for exposure of workers or the general population exists. Direct dermal exposure to and inhalation of fine dust or particles containing HCBd in the workplace are of particular concern.

87. Higher-risk situations specific to HCBd may occur:

- (a) At sites where HCBd is produced;
- (b) At sites where HCBd wastes have been disposed of;
- (c) At sites where HCBd is used;
- (d) At waste electric and electronic equipment (WEEE) management facilities.

2. Lower-risk situations

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

J. Emergency response

89. Emergency response plans should be in place at sites where HCBd is produced, used, stored, transported or disposed of. Further information on emergency response plans is given in section IV.J of the general technical guidelines.

K. Public participation

90. 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

- ATSDR 1994. Agency for Toxic Substances and Disease Registry. Toxicological profile for hexachlorobutadiene. [Atlanta, GA]: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. 162 p. <http://www.atsdr.cdc.gov/toxprofiles/tp42.pdf>
- Baillet, C., Fadli, A., Sawerysyn, J-P. 1996. Experimental Study on the Thermal Oxidation of 1,3-Hexachlorobutadiene at 500-1100°C. *Chemosphere*, Vol. 32, No. 7, pp. 1261-1273.
- BUA 1991/2006: Gesellschaft Deutscher Chemiker, Hexachlorbutadien. BUA-Stoffbericht 263 (BUA Ergänzungsberichte XII; BUA Stoffbericht 62 (August 1991) Ergänzungsbericht (Februar 2006)). Weinheim, VCH.
- Q.-Y. Cai, Q.Y., Mo, C.H., Wu, Q.T., Zeng, Q.Y., Katsoyiannis, A. 2007. Occurrence of organic contaminants in sewage sludges from eleven wastewater treatment plants, China. *Chemosphere* 68 (2007) 1751-1762
- Canada 2013. Annex F Submission on hexachlorobutadiene. <http://chm.pops.int/Convention/POPsReviewCommittee/LatestMeeting/POPRC8/POPRC8Followup/SubmissiononHCBd/tabid/3069/Default.aspx>
- Deutscher, R.L. & Cathro, K.J. 2000. Organochlorine Formation in Magnesium Electrowinning Cells. *Chemosphere* 43 (2001) 147-155.
- EC BREF LVOC 2003. EUROPEAN COMMISSION, Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Large Volume Organic Chemical Industry, February 2003. Currently being updated: working draft of 2014 available at <http://eippcb.jrc.ec.europa.eu/reference/lvoc.html>
- Environment Canada 2000. Priority Substance List Assessment Report, Hexachlorobutadiene, ISBN 0-662-29297-9. <http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl2-lsp2/hexachlorobutadiene/index-eng.php>
- ESWI 2011. BiPRO, Study on waste related issues of newly listed POPs and candidate POPs, BiPRO as part of the Consortium ESWI on behalf of the European Commission, DG Environment, Final Report, 13 April 2011. 841 p. http://ec.europa.eu/environment/waste/studies/pdf/POP_Waste_2010.pdf
- HSDB 2016. Hazardous Substances Database. Hexachlorobutadiene. Accessed 31 March, 2016. <http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/?./temp/~RS2DZd:1>
- Hung, H. 2012. Hexachlorobutadiene (HCBd) Monitored in Canadian Arctic Air. Data Originator: Hayley Hung, Environment Canada (unpublished data) in UNEP/POPs/POPRC.8/16/Add.2. Risk Profile on Hexachlorobutadiene 2012. www.pops.int
- IPCS 1994. Hexachlorobutadiene, IPCS International Programme on Chemical Safety, ISBN 92-5- 157126-X, 1994. <http://www.inchem.org/documents/ehc/ehc/ehc156.htm>
- Jürgens, M.D., Johnson, A.C., Jones, K.C., Hughes, D., Lawlor, A.J. 2013. The presence of EU priority substances mercury, hexachlorobenzene, hexachlorobutadiene and PBDEs in wild fish from four English rivers. *Science of the Total Environment* 461–462 (2013) 441–452 <http://www.sciencedirect.com/science/article/pii/S0048969713005500>
- Kaj L, & Palm A, 2004: Screening av Hexaklorbutadien (HCBd) i Miljon. (Screening of Hexachlorobutadiene (HCBd) in the Environment). Report B1543, Swedish Environmental Research Inst. (IVL), Stockholm, Sweden
- Krantzberg G, Hartig J, Maynard L, Burch K, Ancheta C 1999: Deciding when to intervene. Data Interpretation Tools for Making Sediment Management Decisions Beyond Source Control. Sediment Priority Action Committee –Great Lakes Water Quality Board. <http://www.ijc.org/php/publications/html/sedwkshp/app15.html>
- Lecloux, A. 2004. Hexachlorobutadiene – Sources, environmental fate and risk characterisation. *Science dossier. EuroChlor* 17. 48 p. www.eurochlor.org
- Lee, C-L, Song H-J, Fang M-D. 2000: Concentrations of chlorobenzenes, hexachlorobutadiene and heavy metals in surficial sediments of Kaohsiung coast, Taiwan. *Chemosphere* 41:889–899
- Li, R.T., Going, J.E., Spigarelli, J.L. 1976. Sampling and analysis of selected toxic substances: Task I B.

- Hexachlorobutadiene. Kansas City, Missouri, Midwest Research Institute (EPA Contract No. 68-01-2646).
- Majoros, L.I., Lava, R., Ricci, M., Binici, B., Sandor, F., Held, A., Emons, H. 2013 Full method validation for the determination of hexachlorobenzene and hexachlorobutadiene in fish tissue by GC-IDMS. *Talanta* 116 (2013) 251–258
- Matejczyk, M., Płaza, G.A., Nałęcz-Jawecki, G., Ulfig, K., Markowska-Szczupak, A. 2011. Estimation of the environmental risk posed by landfills using chemical, microbiological and ecotoxicological testing of leachates. *Chemosphere* 82 (2011) 1017–1023.
- PubChem. Open Chemistry Database. National Center for Biotechnology Information. Retrieved 15 March, 2016. https://pubchem.ncbi.nlm.nih.gov/compound/hexachloro-1_3-butadiene#section=Top
- RIWA 2004: Trends van Prioritaire Stoffen over de periode 1977–2002 [Trends of priority substances during the period 1977–2002]. Vereniging van Rivierwaterbedrijven (RIWA). 64 pages (in Dutch) ISBN 90-6683-111-1. <https://www.wageningenur.nl/nl/Publicatie-details.htm?publicationId=publication-way-333333353733>
- Shi, L., Gu, Y., Chen, L., Yang, Z., Ma, J., Qian, Y. 2004. Preparation of graphite sheets via dechlorination of hexachlorobutadiene. *Inorganic Chemistry Communications* 7 (2004) 744–746.
- Staples, B., Howse, MLP, Mason, H., Bell, G.M. 2003. Land contamination and urinary abnormalities: cause for concern? 5 p. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1740564/pdf/v060p00463.pdf>
- Tang, Z., Huang, Q., Cheng, J., Qu, D., Yang, Y., Guo, W. 2014. Distribution and accumulation of hexachlorobutadiene in soils and terrestrial organisms from an agricultural area, East China. *Ecotoxicology and Environmental Safety* 108 (2014) 329–334
- Taylor, P.H., Tirey, D.A., Dellinger, B. 1996. The High-Temperature Pyrolysis of 1,3-Hexachlorobutadiene. *Combustion and Flame* 106:1-10 (1996).
- UBA, 2015. Identification of potentially POP-containing Wastes and Recyclates – Derivation of Limit Values. TEXTE 35/2015. Environmental Research of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. Authors: Potrykus, A., Milunov, M., Weißenbacher, J. BiPRO GmbH, Munich. 279 p. http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_35_2015_identification_of_potentially_pop-containing_wastes.pdf
- 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, May 2007, Geneva, Switzerland.
- UNEP 2015. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants.
- UNEP/POPS/POPRC.8/16/Add.2. Risk Profile on Hexachlorobutadiene 2012. www.pops.int
- UNEP/POPS/POPRC.9/13/Add.2. Risk management evaluation on hexachlorobutadiene 2013. www.pops.int
- US EPA 2003. U.S. Environmental Protection Agency, Office of Water Health Effects. Support Document for Hexachlorobutadiene. EPA 822-R-03-002, February 2003. 135 p. www.epa.gov
- Van der Honing, M. 2007. Exploration of management options for Hexachlorobutadiene (HCBd) Paper for the 6th meeting of the UNECE CLRTAP Task Force on Persistent Organic Pollutants, Vienna, 4-6 June 2007. SenterNovem, The Netherlands, 2007. <http://www.unece.org/fileadmin/DAM/env/lrtap/TaskForce/popsxg/2007/6thmeeting/Exploration%20of%20management%20options%20for%20HCBd%20final.doc.pdf>