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

Technical guidelines

Addendum

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene

Note by the Secretariat

As referred to in document UNEP/CHW.13/6, the annex to the present note sets out the draft technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene which were prepared by the Secretariat, in consultation with the small intersessional working group on the development of technical guidelines on persistent organic pollutant wastes, and take into account comments received by Parties and others pursuant to paragraph 4 of decision OEWG-10/4.[1] The present note, including its annex, has not been formally edited.

[*] UNEP/CHW.13/1.

[1] http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/tabid/5052/Default.aspx.

Annex

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

(Draft of 31 October 2016)

Contents

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 (elimination) to the Stockholm Convention in 2015, through an amendment that entered into force in 15 December 2016. The current guidelines also address unintentionally produced HCBD. It should be noted that unintentionally produced HCBD, however, is currently not subject to the Stockholm Convention provisions.

3. The present technical 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, [ ]) (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).

4. In addition, the use of HCBD as a pesticide is addressed in more detail in the 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 and its salts, 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 (see structural formula in 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).

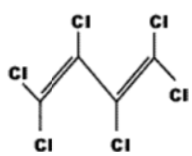

Figure 1: Structural formula of HCBD

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).

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

[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-10/4 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.

ranging from non-detectable to 3.7 µg/kg (grapes) were reported 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, Health Canada, 2000).

2. Production

2.1 Intentional production

8. Parties to the Stockholm Convention must prohibit and/or eliminate the production of HCBD and there are no exemptions under the Convention for HCBD production. HCBD is not known to be currently intentionally produced in Europe, Japan, the United States of America (USA) or Canada.

9. HCBD was first prepared in 1877 by the chlorination of hexyl oxide (IARC 1979). 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 USA 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, Health Canada, 2000).

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

2.2 Unintentional production

11. HCBD is produced unintentionally in the:

(a) Production of certain chlorinated hydrocarbons, particularly of perchloroethylene, trichloroethylene, and carbon tetrachloride (Table 1; Lecloux, 2004; UNEP/POPS/POPRC.9/13/Add.2[2]);

(b) Production of magnesium (Deutscher and Cathro, 2001, Van der Gon et. al, 2007). Fifteen to twenty grams of HCBD arise per tonne of manufactured magnesium (UBA, 2015);

(c) Incineration processes e.g. motor vehicle emissions, incineration processes of acetylene, uncontrolled incineration of chlorine residues, incineration of hazardous waste, municipal waste, clinical waste, and plastic containing waste (Lenoir et al, 2001; UBA, 2015; UNEP/POPS/POPRC.12/CRP.17); and

(d) Production of polyvinyl chloride, ethylene dichloride and vinyl chloride monomer, although this is reported as unlikely from a technological point of view, according to a dossier prepared for the European chloralkali industry (Lecloux, 2004; Van der Gon et. al, 2007).

12. Information on unintentional HCBD production is scarce. High volumes were produced unintentionally in chlorination processes involving organic compounds during the 1970s and 1980s. The worldwide unintentional production of HCBD in heavy fractions was estimated at 10,000 tonnes in 1982 (Lecloux, 2004). In the USA alone, the estimated annual HCBD generation was 3,600 tonnes in 1975, and 12,000 tonnes in 1982 (USEPA, 2003). In 2000, 15,000 tonnes of HCBD was produced unintentionally in the USA (Lecloux, 2004). The unintentionally produced HCBD has been regarded as waste, although it is known to have also been sold partly for commercial uses (BUA, 1991/2006; UNEP/POPS/POPRC.9/13/Add.2).

13. The reported European volumes of unintentionally produced of HCBD 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 in1979 (UBA, 2015). In early 1990's the total amount of HCBD produced in Germany was estimated at 550 –

[2] Revised draft evaluation of new information in relation to the listing of hexachlorobutadiene in Annex C to the Stockholm Convention

1,400 t/year, which was partially directed back into the production process (UBA, 2015). In 1990, an HCBD formation quantity of 2,000 to 49,900 tonnes was estimated based on the production volumes of perchloroethylene and tetrachloromethane in Western Europe (BUA,1991/2006).

14. Processes relevant for the unintentional production of HCBD in the production of chlorinated chemicals 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. Information on the amounts of HCBD in waste from one European producer of chlorinated solvents including perchloroethylene is shown in Table 2.

Table 1: Processes relevant for the unintentional production of HCBD in chlorinated chemicals production (BUA, 1991/2006; 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 fed back into the process together with other high-boiling by-products to carbon tetrachloride and perchloroethylene (Lecloux, 2004) or residues containing HCBD are directly incinerated on site (UBA, 2015).
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)	

Table 2: Volumes of HCBD in waste by a producer of chlorinated solvents including perchloroethylene (Spolchemie in Ústi nad Labem) as reported in the Czech PRTR system. (Source: http://www.irz.cz, 2016)

	2004	2005	2006	2007	2008	2009	2010
HCBD in t/year	161	178	194	175	140	66	162

3. Use[3]

15. Parties to the Stockholm Convention must prohibit and/or eliminate the use of HCBD, and there are no exemptions under the Convention for the use of HCBD. The same provision (Article 3) applies to the use of unintentionally produced HCBD. There is no information on on-going uses of HCBD available. In the past HCBD has been used, for example, as a solvent (for rubber, elastomers and other polymers, for carbon-tetrachloride (C4) and higher hydrocarbons), intermediate in the 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, Health Canada, 2000, UNEP/POPS/POPRC.9/13/Add.2, UBA, 2015).

[3] "Use" covers the use of HCBD for the production of products and articles, as well as the use of those products and articles.

16. Prior to 1975 the largest use of HCBD in 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 Canada, Health Canada, 2000).

17. HCBD was used as a seed-dressing fungicide or insecticide in vineyards in the former Soviet Union (application rate of 100-350 kg/ha), in Mediterranean European countries and in Argentina (Lecloux, 2004; Van der Honing, 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.

18. A method using HCBD to synthesize graphite sheets has been developed relatively recently. 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 HCBD is actually used for this purpose anywhere.

4. Wastes

19. 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 as vineyard fumigant in the former Soviet Union;

(b) HCBD releases can arise from the disposal of old HCBD-containing products that have become waste. Some of the HCBD applications (e.g. hydraulic, heat transfer or transformer fluids) have a long service-life and despite the uses being ceased, HCBD may still enter the waste management stage. 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). There is no further information on possible HCBD residues when used as a chemical intermediate in rubber, elastomer, or lubricant production. However, in a recent study by UBA (2015), HCBD was not found relevant in any waste streams in Germany;

(c) Landfills may be a source of HBCD from disposal of HCBD containing products that have become waste (e.g. hydraulic, cooling and absorbent liquids, HCBD waste from chemical production (typically containing 33-80% HCBD), lining (ebonite) and graphite electrodes removed from chlorine electrolysis cells containing traces of HCBD (Lecloux, 2004). There is no insight into the total amount of waste sites worldwide, nor on their releases (UNEP/POPS/POPRC.9/13/Add.2). In Europe disposal practices of HCBD wastes from unintentional production from chemical and magnesium production have shifted from landfilling to incineration (ATSDR, 1994);

(d) HCBD is also formed during waste incineration (e.g. incineration of municipal waste, clinical waste and hazardous waste) and can be found in incineration residues (ashes and slag) (UBA, 2015);

(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) Old chemicals industry sites may be contaminated by HCBD. In the United States, soil concentration of up to 980 mg/kg were found at chemicals industry sites (Li et al., 1976). Examples of such contamination can also be found in Europe (Barnes et al. 2002).

20. Historical landfilling of heavy fractions from the production of chlorinated organic substances and perchloroethylene use can also lead to secondary HCBD emissions or leachates to water and soil via sewage sludge (ASDTR, 1994, Staples, 2003, Lecloux, 2004, ESWI, 2011). 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. 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 intentionally produced HCBD and unintentionally produced HCBD from chlorinated solvent production and magnesium production;

(b) Residues (ashes and slag) from incineration of unintentionally produced HCBD from chlorinated solvent production, incineration of municipal, clinical and hazardous waste;

(c) Electrical transformers;

(d) Heat exchangers;

(e) Electrical hydraulic fluids, cooling and absorbent liquids;

(f) Other industrial electrical equipment, including removed lining (ebonite) and graphite electrodes from chlorine electrolysis cells;

(g) Rubber compounds;

(h) Sludge from municipal and industrial sewage treatment;

(i) Contaminated soils and sediments from use or disposal of HCBD;

(j) Agricultural insecticides and fungicides.

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

(a) Waste gas and liquid from the production of chlorinated solvents and magnesium (unintentional production of HCBD);

(b) Soils and sediments contaminated from substandard HCBD disposal;

(c) Soils and sediments contaminated from HCBD applied as plant protection;

(d) Obsolete insecticides and fungicides;

(e) Transformer fluids;

(f) Heat exchanging fluids.

22. The most important HCBD waste streams in terms of potential releases or concentration of HCBD are expected to be:

(a) Waste gas and liquid from the production of chlorinated solvents and magnesium (unintentional production of HCBD);

(b) Sludge from municipal and industrial sewage treatment;

(c) Ashes and slag from waste incineration;

(d) Obsolete HCBD insecticide and fungicide waste;

(e) Transformer, heat exchange and hydraulic fluids.

23. 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 3 provides an overview of relevant information regarding the life cycle of HCBD wastes.

Table 3: Overview of the production and application of HCBD and their release media into the environment (Based on Van der Honing, 2007; UNEP/POPS/POPRC.8/16/Add.2 and UNEP/POPS/POPRC.9/13/Add.2).

<table>
<tr><th>Group</th><th>Source materials /Substance used</th><th>Applications /Processes</th><th>End Product</th><th>Release Media</th></tr>
<tr><td colspan="5">HCBD PRODUCTION</td></tr>
<tr><td rowspan="5">Chemical Production</td><td>Chlorine, hexyl iodide (original intentional production process)</td><td>Chemical synthesis</td><td>HCBD</td><td rowspan="5">• Solid waste
• Industrial waste water
• Sludge from waste water treatment
• Air</td></tr>
<tr><td></td><td>Production of perchloroethylene, trichloroethylene and carbon tetrachloride</td><td>Chlorinated hydrocarbons (e.g. tetrachloromethane, Halon 104, Freon 10 etc.), residual HCBD</td></tr>
<tr><td></td><td>Optimised low-pressure chlorolysis for the production of tetrachloroethene and tetrachloromethane</td><td>0.2-0.5% HCBD in the raw product. The residue finally obtained from the process contains after distillation 7-10% HCBD</td></tr>
<tr><td>Acetylene, chlorine</td><td>Production of 1,1,2,2-tetrachloroethane (no longer used according to UNECE, 2007)</td><td>0.4% HCBD</td></tr>
<tr><td></td><td>Production of polyvinyl chloride, ethylene dichloride and vinyl chloride monomer</td><td></td></tr>
<tr><td colspan="5">Production of articles containing HCBD</td></tr>
<tr><td rowspan="5">Chemical applications</td><td>HCBD + unknown</td><td>Production of transformer fluids</td><td>Transformer fluids</td><td rowspan="5">• Solid waste
• Landfill leachate
• Industrial and municipal waste water
• Sludge from waste water treatment
• Air</td></tr>
<tr><td>HCBD + unknown</td><td>Production of heat exchange fluids</td><td>Heat exchange fluids</td></tr>
<tr><td>HCBD + unknown</td><td>Production of fluor-containing hydraulic fluids</td><td>Hydraulic fluids (HCBD residues unknown)</td></tr>
<tr><td>Unknown</td><td>Solvent in production of rubber and elastomers</td><td>HCBD residues unknown</td></tr>
<tr><td>HCBD + unknown</td><td>Production of HCBD plant protection products</td><td>HCBD insecticides and fungicides</td></tr>
<tr><td colspan="5">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)</td></tr>
<tr><td rowspan="3">Electrical equipment</td><td>Transformer fluids</td><td></td><td>Transformer fluid waste, contaminated transformers</td><td rowspan="3">• Solid waste
• Landfill leachate
• Liquid industrial wasteSludge from waste water treatment
• Air</td></tr>
<tr><td>Hydraulic fluids</td><td></td><td>Hydraulic fluid waste, contaminated hydraulic equipment</td></tr>
<tr><td>Gyroscopes</td><td></td><td>Gyroscope fluid waste, contaminated equipment</td></tr>
</table>

Agricultural chemicals	Agricultural insecticides and fungicides		Obsolete pesticide waste (see UNEP, […])	
Incineration processes				
Incineration of waste		Incineration of HCBD waste from production of chlorinated solvents Incineration of municipal, clinical and hazardous waste		• Air • Solid waste (slag and ashes)

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

24. 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").

25. 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.

26. 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.

27. 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).

28. 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) B1110: Electrical and electronic assemblies;

(c) B2060: Spent activated carbon not containing any Annex I constituents to the extent they exhibit Annex III characteristics;

(d) B3040: Rubber wastes.

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

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

(f) Other rubber wastes (excluding such wastes specified elsewhere).

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

B. Stockholm Convention

30. 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.

31. 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

32. The provisional definition of low POP content for HCBD is [1][100] mg/kg.[4]

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

34. Wastes with a content of HCBD above [1][100] mg/kg must be disposed of in such a way

[4] Determined according to national or international methods and standards.

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.

35. Wastes with a content of HCBD at or below [1][100] 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 higher-risk situations).

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

B. Levels of destruction and irreversible transformation

37. 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

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

IV. Guidance on environmentally sound management (ESM)

A. General considerations

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

B. Legislative and regulatory framework

40. 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.

41. 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.

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

C. Waste prevention and minimization

43. 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.

44. 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.

45. The mixing and blending of wastes with HCBD content above [1][100] mg/kg with other materials solely for the purpose of generating a mixture with an HCBD content at or below [1][100] 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.

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

D. Identification of wastes

47. 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.

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

1. Identification

49. 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, including as unintentional production;

(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 landfills and leachate;

(iii) In municipal and industrial wastewater and sludge.

50. 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

51. 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. It is possible, however, that obsolete products and articles with long service-life still enter the waste stage.

52. 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. Large quantity of HBCD is formed unintentionally in chlorinated solvents and magnesium production. It has also been used 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.

53. 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.

E. Sampling, analysis and monitoring

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

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

1. Sampling

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

57. 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).

58. 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

59. 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.

60. 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.

61. 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

62. 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.

63. 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

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

1. Handling

65. 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

66. Collection arrangements that include depots for HCBD wastes should provide for the separation of HCBD wastes from other wastes.

67. Collections depots should not become long-term storage facilities for HCBD wastes.

3. Packaging

68. 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

69. 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

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

6. Storage

71. 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.

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

73. Storage areas for HCBD wastes should have adequate access roads for vehicles.

74. Large amounts of HCBD wastes in storage should be protected from fire.

G. Environmentally sound disposal

1. Pre-treatment

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

2. Destruction and irreversible transformation methods

76. For destruction and irreversible transformation methods for the environmentally sound disposal of wastes with an HCBD content above [1][100] mg/kg, 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

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

4. Other disposal methods when the POP content is low

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

H. Remediation of contaminated sites

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

I. Health and safety

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

1. Higher-risk situations

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

82. 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.

83. Higher-risk situations specific to HCBD may occur:

(a) At sites where HCBD is unintentionally produced;

(b) At sites where HCBD wastes have been disposed of;

(c) At sites where HCBD is used;

(d) At waste electrical equipment management facilities.

2. Lower-risk situations

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

J. Emergency response

85. 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

86. 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

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