Technical guidelines

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

EU+MS General comments

We would like to thank for preparing this draft and for taking into account our comments. We have a few comments which are shown in revision mode and highlighted in yellow.

Annex

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

 Updated version (3 March 2018)

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# **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 Environmental Protection Agency |
| ESM  | environmentally sound management |
| EU | European Union |
| HCBD | hexachlorobutadiene |
| 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 dibenzofuran(s) |
| POP  | persistent organic pollutant |
| UNEP | United Nations Environment Programme |
| WEEE | waste electrical and electronic equipment |

# **Units of measurement**

µg/l microgram per liter. Corresponds to parts per billion

µg/kg microgram per kilogram. Corresponds to parts per billion by mass

mg/kg milligram per kilogram. Corresponds to parts per million by mass

# **I. Introduction**

## **A. Scope**

0. This document supersedes the Technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene of May 2017.

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]](#footnote-2)
2. HCBD was listed in Annex A (elimination) to the Stockholm Convention in 2015, through an amendment that entered into force on 15 December 2016.

2bis. Unintentionally produced HCBD listed in Annex C to the Stockholm Convention (unintentional production) are not covered by the present technical guidelines. They are covered instead by the Technical guidelines on the environmentally sound management of wastes containing or contaminated with unintentionally produced polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, hexachlorobenzene, polychlorinated biphenyls, pentachlorobenzene, polychlorinated naphthalenes or hexachlorobutadiene (Unintentional POPs technical guidelines) (UNEP, XXX).

1. 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, 2017a, to be updated) (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).
2. 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, 2017b).

## **B. Description, production, use and wastes**

### **1. Description**

1. 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

1. 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).
2. HCBD bioaccumulates strongly in rice and vegetables (Tang et al, 2014). In mid-1970s 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) 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 in the 1970s (Environment Canada, Health Canada, 2000).
3. HCBD is easily absorbed and metabolized via conjugation with glutathione. This conjugate can be further metabolized to a nephrotoxic derivative. Kidney tumours were observed in a long-term oral study in rats. HCBD has not been shown to be carcinogenic by other routes of exposure. IARC has placed HCBD in Group 3 (not classifiable as to its carcinogenicity to humans) in 1999 (IARC, 2017).
4. WHO has established a drinking water guideline value of 0.0006 mg/l (0.6 μg/l) (WHO, 2004, 2017) based on a tolerable daily intake of 0.2 µg/kg bodyweight and day.

### **2. Production**

1. 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.
2. HCBD was first prepared in 1877 by the chlorination of hexyl oxide (IARC 1979). The commercial production in Europe stopped in the late 1970s and in Japan in the 1980s. HCBD is also suspected to have been produced in the former USSR. 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).
3. Intentional production of HCBD is already prohibited in Canada, the European Union, Mexico (UNEP/POPS/POPRC.9/13/Add.2), and in Japan.

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### **3. Use[[2]](#footnote-4)**

1. 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, German Federal Environment Agency, 2015).
2. 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).
3. HCBD was used as a seed-dressing fungicide or insecticide in vineyards in the former USSR (application rate of 100-350 kg/ha), in Mediterranean European countries and in Argentina (Lecloux, 2004; Van der Honing, 2007; German Federal Environment Agency, 2015). In France the fumigant use was extensive and discontinued in 2003 (European Commission, 2011). It is unclear whether HCBD is still used as a plant protection product anywhere.
4. 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**

1. 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:
2. The uses of HCBD have apparently ceased, although there are uncertainties related to plant protection use as vineyard fumigant in the former USSR;
3. 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 German Federal Environment Agency, 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 German Federal Environment Agency (2015), HCBD was not found relevant in any waste streams in Germany;
4. Landfills may be a source of HCBD 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);
5. Sites where HCBD pesticides 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/kg after 8 months and 3 mg/kg after 32 months (Vorobyeva (1980) - – the original reference is only available in Russian). However, after 24 months HCBD could not be found in the study;
6. 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);
7. HCBD can be unintentionally produced during waste incineration (e.g. incineration of municipal waste, clinical waste and hazardous waste) and could be found in incineration residues (ashes and slag). However, HCBD was not found in two slag samples above the detection limits in Germany in 2015 (German Federal Environment Agency, 2015).
8. 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, European Commission, 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:
9. HCBD chemical, including intentionally produced HCBD and unintentionally produced HCBD from chlorinated solvent production and magnesium production;
10. Residues (ashes and slag) from incineration of unintentionally produced HCBD from chlorinated solvent production, incineration of municipal, clinical and hazardous waste;
11. Electrical transformers;
12. Heat exchangers;
13. Electrical hydraulic fluids, cooling and absorbent liquids;
14. Other industrial electrical equipment, including removed lining (ebonite) and graphite electrodes from chlorine electrolysis cells;
15. Rubber compounds;
16. Sludge from municipal and industrial sewage treatment;
17. Contaminated soils and sediments from use or disposal of HCBD;
18. Agricultural insecticides and fungicides.
19. The most important HCBD waste streams in terms of potential volume are expected to be:
20. Waste gas and liquid from the production of chlorinated solvents and magnesium (unintentional production of HCBD);
21. Soils and sediments contaminated from substandard HCBD disposal;
22. Soils and sediments contaminated from HCBD applied as plant protection;
23. Obsolete insecticides and fungicides;
24. Transformer fluids;
25. Heat exchanging fluids.
26. The most important HCBD waste streams in terms of potential releases or concentration of HCBD are expected to be:
27. Waste gas and liquid from the production of chlorinated solvents and magnesium (unintentional production of HCBD);
28. Sludge from municipal and industrial sewage treatment;
29. Ashes and slag from waste incineration;
30. Obsolete HCBD insecticide and fungicide waste;
31. Transformer, heat exchange and hydraulic fluids.
32. 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).

| **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
* Industrial waste water
* Sludge from waste water treatment
* Air
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| **Production of articles containing HCBD** |
| **Chemical applications** | HCBD + unknown | Production of transformer fluids | Transformer fluids | * Solid waste
* Landfill leachate
* Industrial and municipal waste water
* Sludge from waste water treatment
* 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) |
| **Electrical equipment**  | Transformer fluids |  | Transformer fluid waste, contaminated transformers  | * Solid waste
* Landfill leachate
* Liquid industrial waste
* Sludge from waste water treatment
* Air
 |
| Hydraulic fluids |  | Hydraulic fluid waste, contaminated hydraulic equipment |
|  Gyroscopes |  | Gyroscope fluid waste, contaminated equipment |
| **Agricultural chemicals** | Agricultural insecticides and fungicides |  | Obsolete pesticide waste (see UNEP, […]) |
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# **II.** **Relevant provisions of the Basel and Stockholm conventions**

## **A. Basel Convention**

1. 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”).
2. Annex I lists some of the wastes which may consist of, contain or be contaminated with HCBD:
3. Y4: Wastes from the production, formulation and use of biocides and phytopharmaceuticals;
4. Y41:Halogenated organic solvents
5. (f)(c) Y45: Organohalogen compounds other than substances referred to in this Annex (e.g. Y39, Y41, Y42, Y43, Y44).
6. 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.
7. 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) A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics;

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

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

1. 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:
2. B2060: Spent activated carbon not containing any Annex I constituents to the extent they exhibit Annex III characteristics;
3. For further information, see section II.A of the General technical guidelines.

## **B. Stockholm Convention**

1. 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.
2. 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**

1. The provisional definition of low POP content for HCBD is 100 mg/kg.[[3]](#footnote-6)
2. The low POP content described in the Stockholm Convention is independent from the provisions on hazardous waste under the Basel Convention.
3. Wastes with a content of HCBD above 100 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.
4. Wastes with a content of HCBD at or below 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).
5. For further information on low POP content, refer to section III.A of the General technical guidelines.

## **B. Levels of destruction and irreversible transformation**

1. 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**

1. See section IV.G below and section IV.G of the General technical guidelines.

# **IV. Guidance on environmentally sound management (ESM)**

## **A. General considerations**

1. For further information, see section IV.A of the General technical guidelines.

## **B. Legislative and regulatory framework**

1. 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.
2. 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:
3. Environmental protection legislation establishing a regulatory regime, setting release limits and establishing environmental quality criteria;
4. Prohibitions on the production, sale, use, import and export of HCBD;
5. 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;
6. Adequate ESM controls to separate HCBD-containing materials from materials that can be recycled (e.g., non-HCBD containing hydraulic fluids);
7. Transportation requirements for hazardous materials and waste;
8. Specifications for containers, equipment, bulk containers and storage sites for HCBD wastes;
9. Specification of acceptable analytical and sampling methods for HCBD;
10. Requirements for waste management and disposal facilities;
11. Definitions of hazardous waste and conditions and criteria for the identification and classification of HCBD wastes as hazardous wastes;
12. 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;
13. Requirements for identification, assessment and remediation of contaminated sites;
14. Requirements concerning the health and safety of workers;
15. Legislative measures on, e.g., waste prevention and minimization, inventory development and emergency response.
16. For further information, see section IV.B of the General technical guidelines.

## **C. Waste prevention and minimization**

1. 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.
2. 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.
3. The mixing and blending of wastes with HCBD content above 100 mg/kg with other materials solely for the purpose of generating a mixture with a HCBD content at or below 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.
4. For further information, see section IV.C on waste prevention and minimization of the General technical guidelines.

## **D. Identification of wastes**

1. 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.
2. For general information on identification and inventories, see section IV.D of the General technical guidelines.

### **Identification**

1. HCBD wastes can be found in the following stages of the HCBD life cycle:

HCBD manufacturing and processing:

Waste generated from the production and processing of HCBD, including as unintentional production;

In water, soil or sediment close to manufacturing, processing sites;

Industrial wastewater and sludge;

Leachate from landfills where chemical manufacturing or processing waste was disposed of;

Stockpiles of unusable or unsellable material;

Industrial applications of HCBD (production of rubber and elastomers, manufacture of transformer, heat exchange, and hydraulic fluids, use as a chemical in chlorine capture):

Residues generated from the application of HCBD;

In water, soil or sediments close to manufacturing or processing sites;

Industrial wastewater and sludge;

Leachate from landfills where waste from industrial applications was disposed of;

Stockpiles of unusable or unsellable products;

Use of products or articles containing HCBD (e.g. HCBD insecticides and fungicides, transformers, hydraulic systems, gyroscopes):

In water, soil or sediments close to sites where such products were used;

Disposal of products or articles containing HCBD:

In certain facilities for the collection, recycling and recovery of electronic and electrical equipment, and;

In municipal and industrial landfills and leachate;

In municipal and industrial wastewater and sludge.

1. 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**

1. 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.
2. A guidance document for the development of HCBD inventories is available (UNEP 2017e).
3. 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. 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:
4. Production of HCBD within a country;
5. 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.

1. 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**

1. For general information on sampling, analysis and monitoring, see section IV.E of the General technical guidelines.
2. Sampling, analysis and monitoring procedures should be established for articles that may contain HCBD.

### **1. Sampling**

1. Sampling serves as an important element for identifying and monitoring environmental concerns and human health risks.
2. 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).
3. 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**

1. 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.
2. 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.
3. HCBD can be analysed together with organochlorine pesticides (see Pesticides technical guidelines, UNEP 2017, xx [to be updated]). 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 biota (at least fish, eggs, milk extracts, vegetables), , wastewater and soils (e.g. EPA Method 612, APHA Method 6410B, APHA Method 6200B) (HSDB 2016, Majoros et al., 2013) and water ((WHO, 2004)). EPA Methods 612 and 625 can be used for analysis of HCBD in industrial and municipal wastewater. The Drinking Water Guideline of WHO reports limits of detection of HCBD in drinking water of 0.01 μg/l by GC-MS; 0.18 μg/l by GC with ECD (WHO, 2017).

### **3. Monitoring**

1. 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. The control of the WHO drinking water quality guideline limit value may serve as an orientation in drinking water programmes (WHO, 2017).
2. 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**

1. For information, see section IV.F of the General technical guidelines.

### **1. Handling**

1. 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**

1. Collection arrangements that include depots for HCBD wastes should provide for the separation of HCBD wastes from other wastes.
2. Collections depots should not become long-term storage facilities for HCBD wastes.

### **3. Packaging**

1. 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**

1. 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**

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

### **6. Storage**

1. 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.
2. Appropriate measures, such as the installation of partitions, should be taken to avoid contamination of other materials and wastes with HCBD.
3. Storage areas for HCBD wastes should have adequate access roads for vehicles.
4. Large amounts of HCBD wastes in storage should be protected from fire.

## **G. Environmentally sound disposal**

### **1. Pre-treatment**

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

### **2. Destruction and irreversible transformation methods**

1. For 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**

1. For information, see subsection IV.G.3 of the General technical guidelines.

### **4. Other disposal methods when the POP content is low**

1. For information, see subsection IV.G.4 of the General technical guidelines.

## **H. Remediation of contaminated sites**

1. For information, see section IV.H of the General technical guidelines.

## **I. Health and safety**

1. For information, see section IV.I of the General technical guidelines.

### **1. Higher-risk situations**

1. For general information, see subsection IV.I.1 of the General technical guidelines.
2. 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.
3. Higher-risk situations specific to HCBD may occur:

 (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**

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

## **J. Emergency response**

1. 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**

1. 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.

Barnes G, Baxter J, Litva A, Staples B. 2002: The social and psychological impact of the chemical contamination incident in Weston Village, UK: a qualitative analysis. Soc Sci Med. 55 (12):2227-41.

BUA 1991/2006: Gesellschaft Deutscher Chemiker, Hexachlorbutadien. BUA-Stoffbericht 263 (BUA Ergänzungsberichte XII; BUA Stoffbericht 62 (August 1991) Ergänzungsbericht (Februar 2006)). Weinheim, VCH. 39 p.

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. 2001. 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, Health 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>

European Commission, 2011. Study on waste related issues of newly listed POPs and candidate POPs. (prepared by the Expert Team to Support Waste Implementation, ESWI). Available at: <http://ec.europa.eu/environment/waste/studies/pdf/POP_Waste_2010.pdf>.

German Federal Environment Agency, 2015. Identification of potentially POP-containing Wastes and Recyclates – Derivation of Limit Values. Available at: <http://www.umweltbundesamt.de/publikationen/identification-of-potentially-pop-containing-wastes>

HSDB 2016. Hazardous Substances Database. Hexachlorobutadiene. Accessed 31 March, 2016. <http://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./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](http://www.pops.int)

IARC (2017). Agents Classified by the IARC Monographs, Volumes 1-120, I.A.f.R.o. Cancer, ed. (Lyon, France: International Agency for Research on Cancer)

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](http://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

Lenoir, D., Wehrmeirer, A., Sidhu, S.S.. Taylor, P.H. 2001. Formation and inhibition of chloroaromatic micropollutants formed in incineration processes, Chemosphere 2001; 43:107-114

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., Nałe˛cz-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).

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 2017a. General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants.

UNEP, 2017b. 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/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

UNEP (2017e) Draft guidance for the inventory of hexachlorobutadiene. UNEP/POPS/COP.8/INF/18.

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](http://www.epa.gov)

Van der Gon, D., van het Bolscher, M., Visschedijk A., Zandveld, P. 2007. Emissions of persistent organic pollutants and eight candidate POPs from UNECE–Europe in 2000, 2010 and 2020 and the emission reduction resulting from the implementation of the UNECE POP protocol, Atmospheric Environment 2007; 41:9245–9261

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>

Vorobyeva T.N. 1980. Residual Amounts of Hexachlorobutadiene in Soils // Chemistry in Agriculture. №11. P.39-40 (in Russian).

WHO (2004). Hexachlorobutadiene in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality (World Health Organization)

WHO (2017). Guidelines for drinking-water quality: fourth edition incorporating the first addendum (Geneva: World Health Organization, Licence: CC BY-NC-SA 3.0 IGO.)

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IARC (2017). Agents Classified by the IARC Monographs, Volumes 1-120, I.A.f.R.o. Cancer, ed. (Lyon, France: International Agency for Research on Cancer).

WHO (2004). Hexachlorobutadiene in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality (World Health Organization).

WHO (2017). Guidelines for drinking-water quality: fourth edition incorporating the first addendum (Geneva: World Health Organization, Licence: CC BY-NC-SA 3.0 IGO.).

1. Decision BC-12/3 and BC-13/4 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. [↑](#footnote-ref-2)
2. “Use” covers the use of HCBD for the production of products and articles, as well as the use of those products and articles. [↑](#footnote-ref-4)
3. Determined according to national or international methods and standards. [↑](#footnote-ref-6)