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

Geneva, 26–30 July 2021 and 6–17 June 2022*

Agenda item 4 (b) (i)

**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 the pesticides aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dicofol, dieldrin, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, lindane, mirex, pentachlorobenzene, pentachlorophenol and its salts, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, technical endosulfan and its related isomers or toxaphene or with hexachlorobenzene as an industrial chemical

Note by the Secretariat

At its fifteenth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal adopted, in decision BC-15/6 on technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants, the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with the pesticides aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dicofol, dieldrin, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, lindane, mirex, pentachlorobenzene, pentachlorophenol and its salts, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, technical endosulfan and its related isomers or toxaphene or with hexachlorobenzene as an industrial chemical, on the basis of document UNEP/CHW.15/6/Add.3. The text of the technical guidelines, as adopted, is set out in the annex to the present note. The present note, including its annex, has not been formally edited.

* In accordance with decisions BC-15/1, RC-10/2 and SC-10/2 of the conferences of the Parties to the Basel, Rotterdam and Stockholm conventions, the 2021/2022 meetings of the conferences of the Parties are being held in two segments: an online segment held from 26 to 30 July 2021 and a face-to-face segment to be held from 6 to 17 June 2022 in Geneva.

Annex

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with the pesticides aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dicofol, dieldrin, endrin, heptachlor, hexachlorobenzene, hexachlorobutadiene, lindane, mirex, pentachlorobenzene, pentachlorophenol and its salts, perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride, technical endosulfan and its related isomers or toxaphene or with hexachlorobenzene as an industrial chemical

(Version of 17 June 2022)

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Abbreviations and acronyms

ATSDR	Agency for Toxic Substances and Disease Registry (United States of America)
BAT	best available techniques
BEP	best environmental practices
DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (dichlorodiphenyltrichloroethane)
EC	emulsifiable concentrate
ECD	electron capture detector
ESM	environmentally sound management
FAO	Food and Agriculture Organization of the United Nations
GHS	Globally Harmonized System for Classification and Labelling of Chemicals
HCB	hexachlorobenzene
HCBd	hexachlorobutadiene
HCH	hexachlorocyclohexane
HEOD	1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-exo-5,8,-dimethanonaphthalene
HHDN	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-exo-5,8-dimethanonaphthalene
HSDB	Hazardous Substances Data Bank (U.S. National Library of Medicine)
IARC	International Agency for Research on Cancer
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
IPCS	International Programme on Chemical Safety (WHO)
LTTD	low temperature thermal desorption
NCI	negative chemical ionization
PCBs	polychlorinated biphenyls
PCDD	polychlorinated dibenzo- <i>p</i> -dioxin
PCDF	polychlorinated dibenzofuran
PFASs	per- and polyfluoroalkyl substances
PFOS	perfluorooctane sulfonic acid
PFOSF	perfluorooctane sulfonyl fluoride
Pesticide POPs	aldrin, chlordane, chlordecone, dicofol, dieldrin, endosulfan, endrin, alpha-HCH, beta-HCH, heptachlor, hexachlorobenzene (HCB), hexachlorobutadiene (HCBd), lindane, mirex, pentachlorobenzene (PeCB), pentachlorophenol (PCP) and its salts, perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF), and toxaphene and HCB as an industrial chemical
POP	persistent organic pollutant
ULV	ultra-low volume
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environment Protection Agency
WHO	World Health Organization

Units of measurement

mg/kg	milligram(s) per kilogram. Corresponds to parts per million (ppm) by mass.
ng	nanogram
mg	milligram
kg	kilogram
Mg	megagram (1,000 kg or 1 tonne)

I. Introduction

A. Scope

1. This document supersedes the Basel Convention's 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 of May 2017.
2. The present technical guidelines provide guidance on the ESM of wastes consisting of, containing or contaminated with the pesticides aldrin, alpha hexachlorocyclohexane (alpha-HCH), beta hexachlorocyclohexane (beta-HCH), chlordane, chlordecone, dicofol, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), hexachlorobutadiene (HCBd), lindane, mirex, pentachlorobenzene (PeCB), pentachlorophenol (PCP) and its salts, perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF), technical endosulfan and its related isomers or toxaphene, or with HCB as an industrial chemical (hereinafter referred to as "pesticide POPs") pursuant to several decisions of two multilateral environmental agreements on chemicals and wastes.¹ Of these, aldrin, chlordane, dieldrin, endrin, heptachlor, HCB, mirex and toxaphene were listed in Annex A to the Stockholm Convention (elimination) at the time of its adoption; the Convention entered into force in 2004. Chlordecone, alpha-HCH, beta-HCH, lindane and pentachlorobenzene were listed in Annex A to the Stockholm Convention and PFOS in Annex B to the Stockholm Convention (restriction) in 2009 and the amendments entered into force in 2010². Technical endosulfan and its related isomers were listed in Annex A to the Stockholm Convention in 2011 and the amendment entered into force in 2012. HCBd and PCP and its salts and esters were listed in Annex A to the Stockholm Convention in 2015, and the amendments entered into force in 2016. Dicofol was listed in Annex A to the Stockholm Convention in 2019 and the amendment entered into force in 2020.
3. The present technical guidelines cover all pesticides currently listed as persistent organic pollutants (POPs) in Annex A to the Stockholm Convention. The pesticide 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (dichlorodiphenyltrichloroethane – DDT), listed in Annex B to the Convention in consideration of its importance for malaria vector control in many tropical countries, is the subject of separate technical guidelines (UNEP, 2006).
4. The technical guidelines also cover HCB as an industrial chemical as the wastes generated are broadly similar to wastes consisting of, containing or contaminated with HCB as a pesticide. ESM for this substance as an industrial chemical is consequently similar to its ESM as a pesticide.
5. Unintentionally produced HCB and PeCB are not covered by these technical guidelines. They are covered in the technical guidelines on the environmentally sound management of wastes containing or contaminated with unintentionally produced PCDDs, PCDFs, HCB, PCBs or PeCBs (Unintentional POPs technical guidelines) (UNEP, 2017a). PFOS used for other purposes than as pesticides is similarly not covered by the present guidelines and is covered instead by the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) and perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds

¹ Decisions IV/17, V/26, VI/23, VII/13, VIII/16, BC-10/9, BC-11/3, BC-12/3, BC-13/4, BC-14/4 and BC-15/6 of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal; decisions OEWG-I/4, OEWG-II/10, OEWG-III/8, OEWG-IV/11, OEWG-V/12, OEWG-8/5, OEWG-9/3, OEWG-10/4, OEWG-11/3 and discussions of the twelfth meeting of the Open-ended Working Group of the Basel Convention; resolution 5 of the Conference of Plenipotentiaries to the Stockholm Convention on Persistent Organic Pollutants; decisions INC-6/5 and INC-7/6 of the Stockholm Convention Intergovernmental Negotiating Committee for a Legally Binding Instrument for Implementing International Action on Certain Persistent Organic Pollutants and decisions SC-1/21, SC-2/6, SC-4/10, SC-4/11, SC-4/12, SC-4/15, SC-4/17, SC-5/3, SC-7/12, SC-7/13, SC-9/4 and SC-9/11 of the Conference of the Parties of the Stockholm Convention.

² The listing of PFOS in Annex B to the Stockholm Convention was amended in 2019 (decision SC-9/4). The Conference of the Parties decided to amend Annex B with a new listing, including amended specific exemptions and acceptable purposes for PFOS. These amendments entered into force on 3 December 2020.

(PFOS and PFOA technical guidelines) (UNEP, 2022).³ HCBd used as an industrial chemical is not covered by the present guidelines and is covered instead by the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene (UNEP, 2017b). PCP and its salts and esters⁴ used for other purposes than as pesticides are not covered by the present guidelines and are covered instead by the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with pentachlorophenol and its salts and esters (UNEP, 2017c).

6. The present document 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 (hereinafter referred to as “General technical guidelines”) (UNEP, 2022). 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).

7. See Annex I for a detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to be taken when using trade names in inventory exercises.

B. Description, production, use and wastes

8. Once an amendment listing a pesticide in Annex A or B to the Stockholm Convention enters into force, Parties shall eliminate or restrict its production and use⁵ unless they have notified the Secretariat of their intention to produce it or use it for an acceptable purpose and/or a specific exemption. Acceptable purposes and specific exemptions for production and use of a pesticide must be explicitly spelled out in the annex in which the pesticide is listed. Table 1 below presents the status of pesticide POPs currently listed in Annex A or B, including the dates of entry into force of the amendments through which they were listed and the status of both production and use exemptions as of July 2021.

9. Unless otherwise specified, according to paragraph 4 of the Stockholm Convention, specific exemptions expire five years from the date of entry into force of the Convention with respect to a particular chemical. With the exception of polychlorinated biphenyls (PCBs), all specific exemptions that were listed in Annexes A and B to the Convention at the time of its entry into force in 2004 became unavailable to all Parties after 18 May 2009. In addition, certain specific exemptions that were listed by subsequent amendments to Annexes A and B to the Convention have also become unavailable. It is to be noted that the amendments to Annexes A and B may take effect on different dates for Parties that have made a declaration pursuant to paragraph 4 of Article 25 or that transmitted a notification of non-acceptance in accordance with paragraph 3 (b) of Article 22. As such, the five-year-period for registration of specific exemptions may vary in accordance with the current practice of the Secretariat. Furthermore, in accordance with paragraph 7 of Article 4, the Conference of the Parties may, upon request from the Party concerned, decide to extend the expiry date of a specific exemption for a period of up to five years.⁶ To date, no such request has been submitted. Chemicals for which no new registrations of specific exemptions are available are indicated in Table 1 as “No longer available”. Information on the current registers of specific exemptions and acceptable purposes for the production and use of pesticide POPs can be found on the Stockholm Convention’s website (<http://www.pops.int>). Information on the status of ratification by the Parties of amendments listing new chemicals in the Stockholm Convention can be found on the website of the Treaty Section of the United Nations (<https://treaties.un.org/>).

³ The present guidelines cover PFOS releases related to pesticide use: pesticides that degrade into PFOS in the environment as well as PFOS salts that have been used as pesticides.

⁴ The ester pentachlorophenyl laurate (PCP-L) has no pesticide use, and it is therefore not covered by these guidelines.

⁵ “Use” covers the use of pesticide POPs for the production of products and articles as well as the use of those products and articles.

⁶ The review process for entries in the Register of Specific Exemptions is set out in the annex to decision SC-1/24 and revised by decisions SC-3/3, SC-4/3 and SC-7/1.

Table 1: Status of pesticide POPs listed under the Stockholm Convention and of specific exemptions/acceptable purposes pertaining to pesticide uses as of July 2021 (Note: Specific exemptions and acceptable purposes for industrial use and consumer products are not included.)

Listed pesticide POPs addressed in the present technical guidelines ⁷	Date of entry into force of the listing ⁸	Annex(es)	Specific exemptions / Acceptable purposes pertaining to pesticide uses available as of July 2021	
			Production	Use
Aldrin	17 May 2004	A	None	No longer available
Alpha hexachlorocyclohexane	26 August 2010	A	None	None
Beta hexachlorocyclohexane	26 August 2010	A	None	None
Chlordane	17 May 2004	A	No longer available	No longer available
Chlordecone	26 August 2010	A	None	None
Dicofol	3 December 2020	A	None	None
Dieldrin	17 May 2004	A	None	No longer available
Endrin	17 May 2004	A	None	None
Heptachlor	17 May 2004	A	None	No longer available
Hexachlorobenzene (HCB)	17 May 2004	A and C	No longer available	No longer available
Hexachlorobutadiene (HCBd)	15 December 2016 ⁹	A and C	None	None
Lindane	26 August 2010	A	None	No longer available
Mirex	17 May 2004	A	No longer available	No longer available
Pentachlorobenzene	26 August 2010	A and C	None	None
Pentachlorophenol and its salts and esters	15 December 2016	A	None for pesticide uses	None for pesticide uses
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride	26 August 2010 ¹⁰ 3 December 2020 ¹¹	B	Acceptable purpose: For the uses listed Specific exemption: None	Acceptable purpose: For the following specific uses, or as an intermediate in the production of chemicals with the following specific uses: <ul style="list-style-type: none">Insect baits with sulfluramid (CAS No: 4151-50-2) as an active ingredient for control of leaf-cutting ants from <i>Atta spp.</i> and <i>Acromyrmex spp.</i>

⁷ <http://chm.pops.int/TheConvention/ThePOPs/AllPOPs/tabid/2509/Default.aspx>

⁸ Unless a Party has made a declaration pursuant to paragraph 4 of Article 25 or submitted a notification of non-acceptance to the depositary in accordance with paragraph 3 (b) of Article 22, amendments to Annexes A, B and C to the Convention enter into force one year after the date the adoption of the amendment is communicated to the Parties by the depositary of the Stockholm Convention. For those Parties that have made a declaration in accordance with paragraph 4 of Article 25, the amendment enters into force on the 90th day after the date of deposit of its instrument of ratification, acceptance, approval or accession.

⁹ The amendment to Annex A to list hexachlorobutadiene entered into force for most Parties on 15 December 2016. The amendment to Annex C to list hexachlorobutadiene entered into force for most Parties on 18 December 2018.

¹⁰ PFOS was listed in Annex B to the Stockholm Convention in 2009 (decision SC-4/17).

¹¹ The listing of PFOS in Annex B to the Stockholm Convention was amended in 2019 (decision SC-9/4)

Listed pesticide POPs addressed in the present technical guidelines ⁷	Date of entry into force of the listing ⁸	Annex(es)	Specific exemptions / Acceptable purposes pertaining to pesticide uses available as of July 2021	
			Production	Use
				for agricultural use only.
Technical endosulfan and its related isomers	27 October 2012	A	As allowed for the Parties listed in the Register of specific exemptions	Crop-pest complexes as listed in accordance with the provisions of part VI of Annex A
Toxaphene	17 May 2004	A	None	None

10. The originally listed pesticide POPs (see paragraph 2 above) were generally manufactured and packaged before the year 2000. In many cases, they have leaked out of their original packages and now appear in inventories as contaminated soil or contaminated building materials, often commingled with many other types of chemicals, including non-POPs, organophosphorus substances, metal phosphides, and organomercury and other heavy metal-based pesticides. In typical inventories of obsolete pesticides found in Africa, the actual quantity of pesticide POPs in commingled stockpiles amounts to no more than 20 per cent by volume.

11. It is rare to find pure technical grade pesticide POPs in obsolete pesticides stockpiles. Almost all obsolete stocks used to be formulated products that were manufactured for particular applications. Formulated products contain one or more active ingredients that are mixed with other ingredients that are added to facilitate the application and action of the active ingredient(s). Types of formulations include ultra low volume (ULV) liquids, emulsifiable concentrates (EC), wettable powders, wettable granules, block baits and smoke tablets. The type of formulation may indicate the physical form and the type of other ingredients that may be present in the formulated product, e.g., both ULV and EC formulations are liquid and contain flammable solvents.

12. In general, the pesticides covered in the present technical guidelines are found in a limited number of types of wastes consisting of, containing or contaminated with pesticide POPs (hereinafter referred to as “pesticide POPs wastes”). For guidance on the identification of pesticide POPs, refer to section IV.D.1 of the present guidelines. Types of pesticide POPs wastes include:

(a) **Production wastes:** Some pesticide POPs wastes can occur as residues from pesticide production processes. For example, the production process for lindane generates a mixture of POP isomers (alpha- and beta-HCH). At some lindane manufacturing facilities large stockpiles of these production wastes have accumulated and have been deposited in landfills (International HCH & Pesticides Association, 2006). Technical grade waste pesticide products are rarely located at closed production facilities anymore;

(b) **Obsolete pesticides :** These can be large or small stockpiles of obsolete pesticides for example in solid or liquid form that are often located in old informal storage sheds and warehouses, or are sometimes found in government-owned facilities. Stockpiles can be found at closed formulation plants, storage facilities for agricultural operations, agricultural and farm supply depots and other distribution facilities, community garden sheds and rural properties. In many cases, the packaging of the pesticides has deteriorated and its contents have leaked;

(c) **Buried pesticides:** It was a common practice in many countries to bury old, obsolete or passed ‘use by date’ pesticides. Usually these burials have commingled chemicals and are a significant problem. Some chemicals like HCB are buried in very large volumes, often with no commingling. Lindane formulations can be found in relatively large burials because, as lindane degrades quite easily it becomes very odorous and the pesticides were buried to reduce the odour;

(d) **Sites where waste has been deposited:** waste of chemicals or products and articles consisting of, containing or contaminated with pesticide POPs have been disposed of in landfills and dumps;

(e) **Contaminated packaging materials and equipment:** following the use of pesticide POPs, their original packaging, application equipment and personal protective equipment could contain residual contamination. These materials and equipment may have been either collected and stored

or in some cases abandoned at the location of the pesticide application. In addition, contaminated empty packaging will result where pesticide POPs stocks have leaked or have otherwise been removed. Contaminated packaging can include: steel or aluminium drums and cans; plastic drums and bottles; cloth or plastic sacks; wooden boxes and pallets; and cardboard or paper boxes and bags;

(f) Contaminated building materials: As a consequence of spillage during pesticide POPs handling or storage, the structures in which the pesticides were held could become contaminated. Typical contaminated building materials include concrete roofs, walls and floor; bricks and mortar; floor coverings; and furniture and equipment;

(g) Contaminated sewage sludge: sewage sludge can contain pesticide POPs and land-based dispersal of the sludge can lead to pesticide POPs contamination of soil. It also can result in contaminated marine sediment in harbours or coastal areas where there is sewage or stormwater discharge into the marine environment;

(h) Contaminated soil¹²: In general contaminated soils occur where the pesticides were kept or stored and over time have leaked (or in the case of solids – fallen) onto the soils below their storage. This is particularly the case for stocks of the pesticide POPs that were listed to Annex A in 2004, whose containers have disintegrated or where the contents have been deliberately emptied onto the ground to allow the containers to be used for other purpose. This applies to farmers' sheds that have soil floors and in many cases also applies to formulators or distributors who stored bulk pesticides outside of their facilities. Contaminated soils are also found on farms where obsolete pesticide POPs have been buried and in areas where pesticides have been spilled while they were being mixed and loaded into application equipment. For example, contaminated soil can be found at air strips used by planes involved in the aerial spraying of pesticides. Pesticide manufacturing facilities are also potential locations of contaminated soils. Contaminated soils may also occur where pesticides have been extensively used and applied (e.g. farms, outdoor public spaces, transportation corridors, and utility infrastructure). Also widespread over-application can result in a large volume of soil contaminated with pesticides POPs;

(i) Contaminated sediment: leaching of pesticide POPs from storage or burial can result in contaminated sediments in waterways and lakes;

(j) Contaminated water: some pesticide POPs have been used to control microbial growth as slime control in pulp and paper production and cooling tower water;

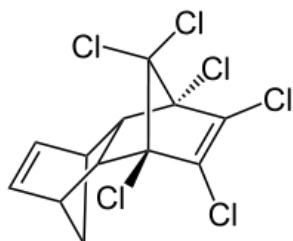
(k) Preserved materials: Pesticide POPs have also been used for preservation of materials against microbial decay, in particular for wood and textiles. These include building materials, wool, cotton, flax and jute fabrics and yarns used in covers, tarpaulins, awnings, tents, webbing and netting and also sisal and manila ropes.

13. Subsections 1-16 immediately below describe the pesticide POPs covered by the present guidelines. Under each such subsection, paragraph (d) describes the types of waste in which the relevant pesticide POP is typically found.

1. Aldrin

(a) Description

Figure 1: Structural formula of aldrin



14. Aldrin (CAS No: 309-00-2) is a white, odourless crystal when it is pure. The structural formula of aldrin is shown in **Error! Reference source not found.** above. Technical grades are tan to dark brown and have a mild chemical odour (Ritter et al., 1995). Aldrin is almost insoluble in

¹² See European Network of Lindane waste affected regions (<https://www.interregeurope.eu/lindanet/>) for more information about the situation and actions in Europe.

water, moderately soluble in petroleum oil and stable to heat, alkalis and mild acids (ATSDR, 2002; IPCS INCHEM, no date; WHO-FAO, 1979). Aldrin is non-corrosive or slightly corrosive to metals because of the slow formation of hydrogen chloride during storage. Aldrin is a precursor of dieldrin, which is also listed in Annex A to the Stockholm Convention, and the two are chemically closely related. Aldrin residues in soil and plants will volatilize from soil surfaces or slowly transform into dieldrin in soil. Biodegradation of aldrin is expected to be slow and the chemical is not expected to leach into groundwater. Its bioconcentration is significant, as is its adsorption to sediments. (Howard, 1991, p.12)

(b) Production

15. Aldrin was produced in the United States of America by Shell International Chemical Company, with production ceasing in 1985 and final deregistration by the United States Environmental Protection Agency (EPA) in 1987. Aldrin was banned in most countries in the early 1970s and there is no known current production of the chemical. Aldrin is listed in Annex A to the Stockholm Convention (“Elimination”), with no specific exemptions for production.

(c) Use

16. Aldrin was used throughout the world until the early 1970s to control soil pests such as corn rootworm, wireworms, rice water weevil and grasshoppers. It was also used to protect wooden structures and plastic and rubber coverings of electrical and telecommunication cables (ATSDR, 2002; UNEP, 2002a). In 1966, aldrin use in the United States of America peaked at 8,550 tonnes and by 1970 had decreased to 4,720 tonnes (ATSDR, 2002; UNEP, 2003). There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

17. In the field, aldrin can be found as an ingredient in formulations such as emulsifiable concentrates to which epichlorhydrin has been added to delay corrosion and inhibit dehydrochlorination, and wettable powders 40-70 per cent to which urea has been added to prevent dehydrochlorination by certain carriers.

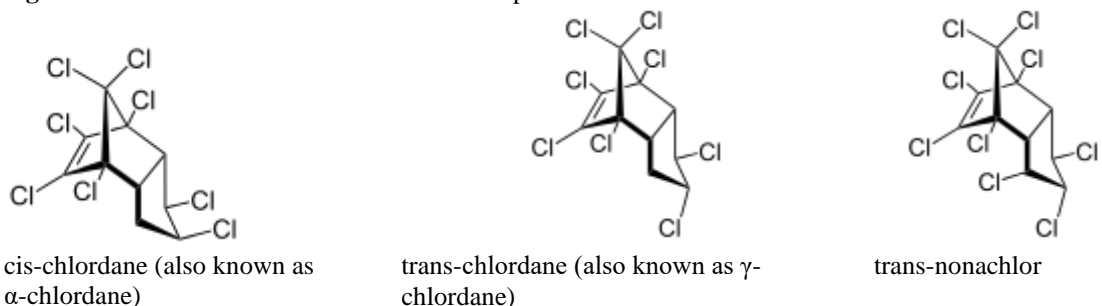
(d) Waste

18. Parties, in accordance with their Stockholm Convention national implementation plans, have reported few stockpiles of aldrin. Waste aldrin can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment;
- (i) Preserved materials.

2. Chlordane

Figure 2: Structural formulas of chlordane components



(a) Description

19. Chlordane (CAS No: 57-74-9) is not a single chemical, but is a mixture of many related chemicals, of which about 10 are major components. The principal constituents of technical chlordane are trans-chlordane (gamma-chlordane) (about 25 per cent), cis-chlordane (alpha-chlordane) (about 70 per cent), heptachlor, trans-nonachlor and cis-nonachlor (< 1 per cent). Technical chlordane also contains other chlorinated hydrocarbons and by-products. The structural formulas of some of chlordane main components are shown in **Error! Reference source not found. Error! Reference source not found.** Heptachlor is one of the most active components of technical chlordane, which is a colourless or amber-coloured liquid with a chlorine-like odour. Technical chlordane is not soluble in water and is stable in most organic solvents, including petroleum oils. The US EPA considers as technical chlordane another mixture identified by CAS No: 12789-03-6 and composed of 60 per cent octachloro-4,7-methanotetrahydroindane (the cis and trans isomers) and 40 per cent related compounds (see Integrated Risk Information System (IRIS) database).

(b) Production

20. Chlordane was produced by several chemical companies over many years and the original patent holder was the chemical company BASF-GmbH. Chlordane was deregistered by US EPA in 1978 and was banned in most countries in the early 1970s. The last company that manufactured the chemical (Velsicol Chemical Company) stopped producing and exporting it in 1997 (Fiedler et al., 2000; UNEP, 2002a). Chlordane is listed in Annex A to the Stockholm Convention ("Elimination"). There are no specific exemptions for production of the chemical under the Stockholm Convention (previous exemptions have expired).

(c) Use

21. Chlordane, which was introduced onto the market for the first time in 1945, is a broad-spectrum contact insecticide that was employed on agricultural crops and on lawns and gardens. It was also used extensively in the control of termites, cockroaches, ants, and other household pests (Fiedler et al., 2000; UNEP, 2002a).

22. Between 1983 and 1988, the sole use of chlordane was for the control of subterranean termites. For that purpose, chlordane was applied primarily as a liquid that was poured or injected around the foundations of buildings. Chlordane, in conjunction with heptachlor, was once also widely used as a pesticide for the control of insects on various types of agricultural crops and other vegetation (Fiedler et al., 2000; UNEP, 2002a). Use in Tajikistan was still being reported in 2002 (UNEP, 2002b). There are no specific exemptions for use of chlordane under the Stockholm Convention (previous exemptions have expired).

23. Chlordane has been available in formulated products including granules, oil solutions and emulsifiable concentrates sometimes mixed with heptachlor (Worthing and Walker, 1987; WHO, 1988).

(d) Waste

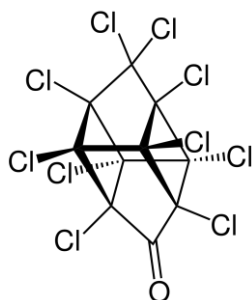
24. Waste chlordane can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

3. Chlordecone

(a) Description

Figure 3: Structural formula of chlordecone



25. Chlordecone (CAS No: 143-50-0) is a synthetic chlorinated organic compound. Previously also known as Kepone, chlordecone is a highly stable, odourless, white or tan-coloured solid. The structural formula of chlordecone is shown in **Error! Reference source not found. Error! Reference source not found.** While its solubility in water is low, chlordecone readily dissolves in some organic solvents (e.g., acetone, ketone and acetic acid) and it is slightly soluble in benzene and hexane. Chlordecone is also a contaminant in mirex formulations and is a degradation product of mirex (Bus and Leber, 2001). Chlordecone is resistant to degradation in the environment (Integrated Risk Information System (IRIS) database). It is not expected to react with hydroxyl radicals in the atmosphere or to hydrolyse or photolyze. Chlordecone in the air is likely to be removed by deposition of particles. Studies have shown that microorganisms degrade chlordecone slowly. Chlordecone is expected to adsorb to soil and to stick to suspended solids and sediments in water. Small amounts of chlordecone will evaporate from soil or water surfaces (NLM, 2004). Chlordecone has a high potential for bioaccumulation in fish and other aquatic organisms (ATSDR, 1995; ATSDR, 2019d).

(b) Production

26. Chlordecone was produced and exported by Allied Chemicals in the United States of America, where production ceased in 1977. Between 1951 and 1975, approximately 1.6 million kg of chlordecone were produced in the United States of America (Epstein, 1978). Approximately 90-99 per cent of the total volume of chlordecone produced during this time was exported to Europe, Asia, Latin America, and Africa (DHHS 1991; EPA, 1978b quoted in ATSDR, 1995 and ATSDR, 2019a). In the United States of America, its registration was cancelled by US EPA in 1978 (Metcalf, 2002; IARC, 1979). Chlordecone is listed in Annex A to the Stockholm Convention ("Elimination"), under which there are no specific exemptions for production of the chemical.

(c) Use

27. Chlordecone was used as an insecticide on tobacco, ornamental shrubs, bananas and citrus trees and in ant and roach traps. Specific applications have included control of the banana root borer, application on non-fruit-bearing citrus trees to control rust mites, control of wireworms in tobacco fields, control of apple scab and powdery mildew, control of grass mole crickets, and control of slugs, snails and fire ants (NLM, 2004; ATSDR, 1995; ATSDR, 2019d). Chlordecone continued to be used in several countries, including Zambia in 2014. Although it was banned in the United States of America in 1978, use was still recorded in Hawaii in the 1990s (Allen et al., 1997). There are no specific exemptions for use of the chemical under the Stockholm Convention.

28. Approximately 55 different commercial formulations of chlordecone have been prepared since its introduction in 1958 (Epstein, 1978). The major formulation of chlordecone, which was used as a pesticide on food crops, was a wettable powder (50 per cent chlordecone) (Epstein 1978). Formulations of chlordecone commonly used in non-food products were granules and dusts containing 5 or 10 per cent active ingredient (Epstein, 1978). Other formulations of chlordecone contained the following percentages of active ingredient: 0.125 per cent (used in the United States of America in ant and roach traps), 5 per cent (exported for banana and potato dusting), 25 per cent (used in the United States of America in ant and roach bait), 50 per cent (used to control mole crickets in Florida), and 90 per cent (exported to Europe for conversion to kelevan for use on Colorado potato beetles in Eastern European countries) (Epstein, 1978; ATSDR, 1995; ATSDR, 2019a).

(d) Waste

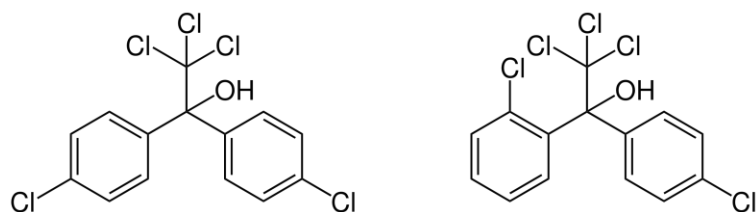
29. Waste chlordecone can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

4. Dicofol

(a) Description

Figure 4: Structural formula of dicofol isomers p,p'-dicofol (CAS No: 115-32-2) and o,p'-dicofol (CAS No: 10606-46-9, right).



30. Dicofol is an organochlorine pesticide comprising two isomers: p,p'-dicofol and o,p'-dicofol (Figure 4). The technical product (95% pure) is a brown viscous oil and is composed of 80-85% p,p'-dicofol and 15-20% o,p'-dicofol with up to 18 reported impurities. The purer form generally contains more than 95% dicofol and less than 0.1% dichlorodiphenyltrichloroethane (DDT) and related compounds (Σ DDT, i.e. DDT, DDE and DDD) (WHO, 1996).

(b) Production

31. Dicofol can be manufactured by the hydroxylation of DDT, or directly, without isolation of DDT by the reaction of chloral (trichloroacetaldehyde) with monochlorobenzene in the presence of oleum (SO_3 and H_2SO_4) followed by dehydrochlorination, chlorination and hydrolysis. Dicofol is listed in Annex A to the Stockholm Convention ("Elimination"), with no specific exemptions for production. The production and use of DDT as a closed-system site-limited intermediate in the production of dicofol is currently possible until May 2024 (decision SC-7/1 (UNEP/POPS/COP.7/36)).

32. In the early 2000's global production of dicofol was estimated to have been 2,700 - 5,500 tonnes per year. It has been estimated that production has declined sharply since 2007 as number of countries have phased out production and usage of dicofol (UNEP/POPS/POPRC.13/7/Add.1).

33. According to the Stockholm Convention Risk management evaluation on dicofol (UNEP/POPS/POPRC.13/7/Add.1), the production took place in a small number of countries in 2017. This included one manufacturer (Hindustan Insecticides Limited (HIL)) in India. Additionally, an Israeli company Adama¹³ (formerly Makhteshim Agan) has a registered product containing dicofol (Acarin T 285). In 2015-2016 production at the facility in India was 93 t with dicofol produced in a closed system as a batch process. Production is now believed to have ceased.

34. China was one of the major producers of technical DDT and dicofol until 2014. It was estimated that 40,000 tonnes of dicofol was produced between 1988 and 2002. In 2014, it was reported that the last remaining technical dicofol producer in China ceased production (UNEP/POPS/POPRC.13/7/Add.1).

35. Brazil manufactured around 90 tonnes of dicofol per annum until 2010 but has ceased production in 2014. Remaining stocks in Brazil were expected to have been fully used/destroyed by 2015. Dicofol is no longer produced in the European Union. Production in the USA was estimated at 160 tonnes/y for the years 1999 to 2004 (UNEP/POPS/POPRC.13/7/Add.1).

¹³ <http://www.pcpb.or.ke/cropproductsviewform.php>.

(c) Use

36. Dicofol was used in many countries to control mites on a variety of crops since it was introduced commercially in 1955 (WHO, 1996). It has been used primarily in East and Southeast Asia, the Mediterranean coast, as well as in Northern and Central America. China was the main user of dicofol in the early 2000's (UNEP/POPS/POPRC.13/7/Add.1).

37. Dicofol uses included application on fruits, vegetables, ornamentals such as orchids, field crops, cotton, tea, Christmas tree plantations, and non-agricultural outdoor buildings and structures. In Mexico it was authorized for application on aubergine, chili, strawberry, lime, apple, orange, pear, watermelon, mandarin, grapefruit, vine, citrus fruits, ornamental plants and nursery gardens in 2017. In Brazil, dicofol was used as an acaricide for cotton, citrus and apple crops until all use as a pesticide was banned in 2015 (UNEP/POPS/POPRC.13/7/Add.1).

38. Between 2000 and 2012 the estimated dicofol usage decreased by 75% in China (from 2,013 tonnes to 530 tonnes), 69% in India (from 145 tonnes to 43 tonnes) and 90% in the USA (from 323 tonnes to 33 tonnes) with most use occurring in California, Florida, and Georgia for that time frame. The decrease of estimated global use from 2000 (3,350 t) to 2012 (730 t) was approximately 80%. In Europe dicofol usage was estimated to have decreased from 317 tonnes to 32 tonnes between 2000 and 2009. The major consumers in Europe in 2000 were Spain, Italy, Turkey, Romania, and France. Dicofol has been used in Ukraine, but the current situation is unclear (UNEP/POPS/POPRC.13/7/Add.1).

39. In 2017 it was estimated that the current global dicofol use was well below 1,000 t/y. (UNEP/POPS/POPRC.13/7/Add.1). There are no specific exemptions for use of the chemical under the Stockholm Convention.

(d) Waste

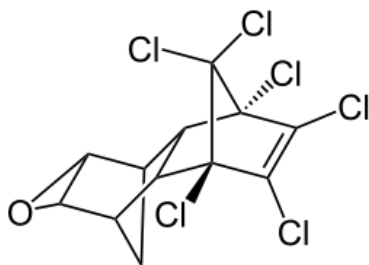
40. Waste dicofol can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

41. Dicofol production waste may also contain DDT as an impurity. For instance, up to 14.3% DDT was found in dicofol formulations in Turkey (Turgut et al., 2009).

5. Dieldrin**(a) Description**

Figure 5: Structural formula of dieldrin



42. Dieldrin (CAS No: 60-57-1) is a technical product containing 85 per cent 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-exo-5,8,-dimethanonaphthalene (HEOD). Dieldrin is closely related to its precursor aldrin. The structural formula of dieldrin is shown in Figure 5 above. Its pure major ingredient, HEOD, is a white crystalline solid with a melting point of 176°C–177°C. Technical dieldrin is a light tan, flaky solid with a melting point of 150°C. It is almost completely insoluble in water and slightly soluble in alcohol. Pure HEOD is

stable in alkalis and dilute acids, but reacts with strong acids (ATSDR, 2002; IPCS INCHEM, no date; WHO-FAO, 1975a).

(b) Production

43. Dieldrin was developed by J. Hyman & Co. and licenced to Shell International Chemical Co. and Velsicol Chemical Company in the United States of America. It was exported throughout the world. The US EPA banned dieldrin in 1987 and production ceased that year. Dieldrin is listed in Annex A to the Stockholm Convention (“Elimination”) and there are no specific exemptions for production of the chemical under the Convention.

(c) Use

44. Dieldrin was used for the control of soil insects such as corn rootworms, wireworms and cutworms (UNEP, 2002a) and for the control of desert locusts. In India, its manufacture and import were banned by an order dated 17 July 2001, but marketing and restricted use (for locust control) were permitted until the passage of two years from the date of the ban or up to the date of expiry of existing stocks, whichever came first. There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

45. Dieldrin was formulated as liquids and solids in a wide range of concentrations. Formulations for locust control (the main dieldrin product found in obsolete pesticide stocks) typically contained between 50 and 200 g/l of dieldrin active ingredient.

(d) Waste

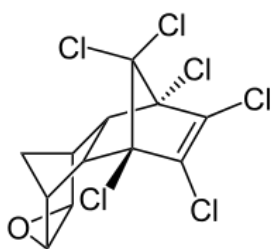
46. Waste dieldrin can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

6. Endrin

(a) Description

Figure 6: Structural formula of endrin



47. Endrin (CAS No: 72-20-8), when pure, is a white crystalline solid with a melting point of 200°C. The structural formula of endrin is shown in Figure 6 above. Endrin decomposes at temperatures above 245°C (boiling point). The technical product is a light tan powder with a characteristic odour. It is nearly insoluble in water and slightly soluble in alcohol. It is stable in alkalis and acids, but it rearranges to less insecticidally active substances in the presence of strong acids, when exposed to sunlight, or when heated to above 200°C (ATSDR, 1996; IPCS INCHEM, no year; WHO-FAO, 1975b; ATSDR, 2019c).

(b) Production

48. Endrin was developed by J. Hyman & Co. and was licenced to Shell International Chemical Co. and by Velsicol Chemical Company in the United States of America until 1991. Shell ceased manufacture of the chemical in 1982. Endrin is listed in Annex A to the Stockholm Convention (“Elimination”), under which there are no specific exemptions for production of the chemical.

(c) Use

49. Endrin was first used as an insecticide, rodenticide and avicide to control cutworms, mice, voles, grasshoppers, borers and other pests on cotton, sugar cane, tobacco, apple orchards and grain. It was also used as an insecticide agent on bird perches but was never used extensively for termite-proofing or other applications in urban areas, despite its many chemical similarities to aldrin and dieldrin. All other uses of endrin in the United States were voluntarily cancelled by the manufacturer in 1986, except for use as an avicide on bird perches, which was cancelled in 1991 (ATSDR, 2019c). Endrin's toxicity to non-target populations of raptors and migratory birds was one of the main reasons why its use as a pesticide agent was cancelled in the United States of America (Blus et al., 1989). There are no specific exemptions for use of the chemical under the Stockholm Convention.

50. Endrin formulations included emulsifiable concentrates, wettable powders, dusts and granules.

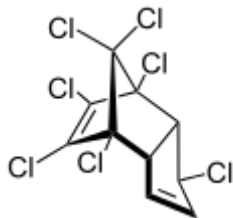
(d) Waste

51. Waste endrin can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

7. Heptachlor**(a) Description**

Figure 7: Structural formula of heptachlor



52. Pure heptachlor (CAS No: 76-44-8) is a white crystalline solid with a melting point of 95°C –96°C. The structural formula of heptachlor is shown in Figure 7 above. Technical heptachlor is a soft, waxy solid with a melting range of between 46°C and 74°C. It is nearly insoluble in water and slightly soluble in alcohol. It is stable up to temperatures between 150°C and 160°C and when exposed to light, air moisture, alkalis and acids. It is not readily dechlorinated but is susceptible to epoxidation (ATSDR, 2007; IPCS INCHEM, no year; WHO-FAO, 1975c). Heptachlor is a persistent dermal insecticide with some fumigant action. It is not phytotoxic at insecticidal concentrations. When heptachlor is released to the environment and exposed to oxygen, heptachlor epoxide is formed.

(b) Production

53. The original patent holder and maker of heptachlor was chemical company BASF-GmbH AG. In the United States of America, heptachlor was manufactured until 1997 by the Velsicol Chemical Company, which exported it to more than 20 countries, mainly in tropical regions. Heptachlor is listed in Annex A to the Stockholm Convention ("Elimination"), under which there are no specific exemptions for production of the chemical.

(c) Use

54. Heptachlor was used extensively from 1953 to 1974 as a soil and seed treatment to protect maize, small grains and sorghum from pests and to control ants, cutworms, maggots, termites, thrips, weevils and wireworms in both cultivated and uncultivated soils. In non-agricultural

applications, heptachlor was used during the same period of time to control termites and household insects (ATSDR, 2007; Fiedler et al., 2000). Heptachlor was also used in the production of chlordane. There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

55. Technical-grade heptachlor contains about 72 per cent heptachlor and 28 per cent related compounds (20 per cent –22 per cent trans-chlordane and 4 per cent –8 per cent nonachlor). Formulations have included emulsifiable concentrates, wettable powders, dusts and granules containing various concentrations of active material (National Cancer Institute, 1977; Izmerov, 1982; Worthing and Walker, 1987; FAO/WHO, 1989; Tomlin, 1999).

(d) Waste

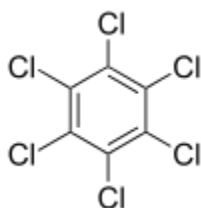
56. Waste heptachlor can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

8. Hexachlorobenzene (HCB)

(a) Description

Figure 8: Structural formula of hexachlorobenzene



57. Hexachlorobenzene (HCB) (CAS No: 118-74-1) is a chlorinated monocyclic aromatic compound in which the benzene ring is fully substituted by chlorine. The structural formula of HCB is shown in Figure 8 above. HCB is a white crystalline solid with a melting point of 231°C that is nearly insoluble in water but is soluble in ether, benzene and chloroform (NTP, 2014). It has a high octanol-water partition coefficient, low vapour pressure, moderate Henry's Law constant and low flammability. HCB is found almost exclusively in the solid phase (as is predicted by its vapour pressure), with under 5 per cent associated with particles in all seasons except winter, where levels are still below 10 per cent particle-bound (Cortes et al., 1998).

(b) Production

58. HCB was first introduced in 1945 as a fungicide. Its production started to fall in the 1970s and ceased in 1986, as many countries banned its use in agriculture. In the USA it has not been commercially produced since the late 1970s (ATSDR, 2015a). Unintended production of industrial HCB was a by-product of the manufacture of chlorinated solvents including perchloroethylene (also known as tetrachloroethylene, PER or PERC), carbon tetrachloride and trichloroethylene. HCB was also a by-product of polyvinyl chloride manufacture. Large stockpiles of HCB wastes from production accumulated throughout the world until the end of the 1980s. HCB is listed in Annex A to the Stockholm Convention ("Elimination"), under which there are no specific exemptions for production of the chemical (previous exemptions have expired).

(c) Use

59. Historically, the major use of HCB as a pesticide was as a fungicide. HCB was used worldwide as an agricultural fungicide from the early twentieth century, particularly as a seed dressing to prevent fungal diseases in grain and other field crops. Its use was particularly extensive in the former Soviet Union, giving rise to significant environmental concerns associated with the chemical in the countries of that region. Pesticide uses of HCB have been effectively discontinued

in most countries, where reductions began in the 1970s and led to a near-complete phase-out by the early 1990s. In the United States the last registered use of the compound as a pesticide was voluntarily cancelled in 1984 (ATSDR, 2015a). There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

60. HCB formulations included dust to prevent fungal attacks containing 10 -40 per cent HCB, often mixed with other seed protectants, particularly lindane (0.5 -1.0 per cent), to prevent insect attacks on stored seeds.

61. Other uses include:

(a) As chemical intermediates in the formation of rubber auxiliary pentachlorothiophenol, as a peptizing agent in the production of nitroso and styrene rubbers for use in vehicle tyres, the production of pentachlorophenol and the production of aromatic fluorocarbons. It is believed that those chemical intermediate applications have ceased in most countries (Bailey, 2001);

(b) Dispersive non-pesticide end-uses, including wood preservation, paper impregnation, to control porosity in the manufacture of graphite electrodes, and in the manufacture of aluminium and military pyrotechnic products, including tracer bullets, and fireworks (CLEEN, 2012). These uses have been discontinued almost completely and the only reference found to end-uses since 2000 pertains to pyrotechnic and smoke-generating products in the Russian Federation (Shekhovtsov, 2002).

(d) Waste

62. Waste HCB pesticides can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment;
- (i) Preserved materials.

63. Waste HCB as an industrial chemical can be found in:

(a) Stockpiles of HCB production waste from polyvinyl chloride manufacturing facilities, either as packages or as underground burials;

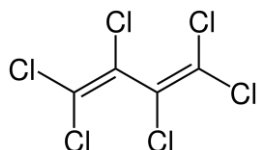
(b) Solids, sludges, suspensions and solutions containing significant concentrations of HCB (typically > 1,000 mg/kg) from production processes;

(c) Solids, sludges, suspensions and solutions containing low concentrations or trace amounts of HCB (typically < 50 mg/kg), e.g., contaminated soils in the vicinity of HCB stockpiles or of processes that produced HCB either intentionally, or in significant quantities as an unintended by-product;

(d) Contaminated wood, paper and plastic materials in which HCB was used for impregnation or as an additive;

(e) Old graphite electrodes from certain obsolete electrolytic processes;

(f) Pyrotechnic products and smoke-generating products and equipment of civilian or military origin.

9. Hexachlorobutadiene (HCBD)¹⁴**(a) Description****Figure 9:** Structural formula of hexachlorobutadiene

64. HCBD (CAS No: 87-68-3) is a halogenated aliphatic compound. The structural formula of HCBD is shown above in Figure 9. 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).

(b) Production

65. HCBD has been produced both intentionally and as an unintentional by-product, mainly during the manufacture of chlorinated chemicals. Unintentionally produced HCBD has also been placed on the market for commercial uses.

66. 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 United States of America or Canada, (USEPA, 2003, Van der Honing, 2007, Canada, 2013; ATSDR, 2019d). However, possible remaining intentional production (particularly in quantities below the limits for high-production volumes) in other regions cannot be excluded (UNEP/POPS/POPRC.9/13/Add.2). There are no natural sources of HCBD in the environment (Environment Canada, 2000).

67. HCBD is listed in Annex A to the Stockholm Convention ("Elimination"), under which there are no specific exemptions for production of the chemical. It is also listed in Annex C to the Stockholm Convention ("Unintentional production").

(c) Use

68. There is little information available on HCBD pesticide use. It was used as a seed-dressing fungicide or fumigant insecticide against parasitic pest Phylloxera in vineyards at least in the former Soviet Union 600-800 tonnes per year in mid-1970's (application rate of 100-350 kg/ha), and in France, Italy, Greece, Spain, and Argentina (IARC, 1979; Lecloux, 2004; German Federal Environment Agency, 2015; Van der Honing, 2007). 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, but widespread use no longer occurs (Lecloux, 2004).

69. There are no specific exemptions for use of the chemical under the Stockholm Convention.

(d) Waste

70. Waste HCBD pesticides can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated sewage sludge;
- (h) Contaminated soil;

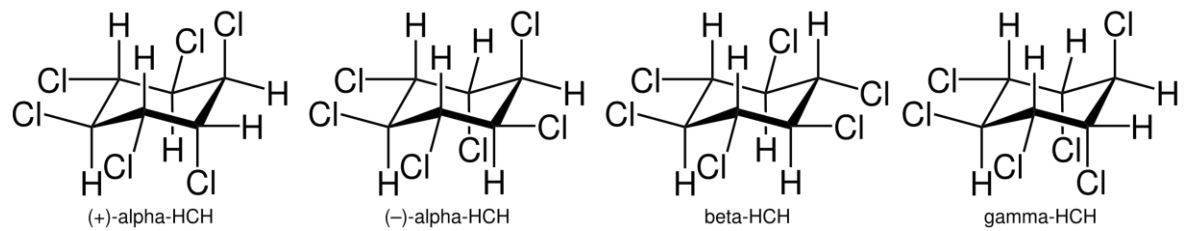
¹⁴ With respect to HCBD used for other purposes than pesticides, see the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene (UNEP, 2017a).

(i) Contaminated sediment.

10. Lindane, alpha- and beta-hexachlorocyclohexane

(a) Description

Figure 10: Structural formulas of lindane (gamma-HCH), alpha-HCH and beta-HCH



71. Lindane (CAS No: 58-89-9) is the common name for the gamma isomer of hexachlorocyclohexane (γ -HCH). Technical HCH is an isomeric mixture that contains mainly five forms, namely alpha-, beta-, gamma-, delta- and epsilon-HCH (Figure 10). Lindane is also known as gammaxene and Gammallin and erroneously known as benzene hexachloride (BHC). Lindane is a white poisonous crystalline powder with a slight musty odour; its IUPAC name is 1,2,3,4,5,6-hexachlorocyclohexane.¹⁵

72. Technical lindane also contained alpha-HCH (CAS No: 319-84-6) and beta-HCH (CAS No: 319-85-7), which are produced as unintentional by-product and have no insecticidal properties (ATSDR, 2005). For each ton of lindane produced, around 6-10 tons of the other isomers including alpha- and beta-HCH are created.

73. The structural formulas of lindane, alpha-HCH and beta-HCH are shown in Figure 10 above. The isomers differ with regard to the spatial orientation of the hydrogen and chlorine atoms on the carbon atoms (IPCS, 1991). The biological activity of mixed isomers is further exemplified by delta-HCH's potent cytotoxicity, mainly through the induction of thymocyte necrosis (Sweet et al., 1998).

(b) Production

74. A method for the industrial production of HCH was first patented in 1940. Technical grade HCH contains 10-15 per cent lindane, as well as the alpha, beta, delta and epsilon forms of HCH, which are unintentionally produced as by-products in the manufacturing process. The alpha and beta forms of HCH typically form 65-70 per cent and 7-10 per cent, respectively, of technical HCH during synthesis. The original patent holder and maker of HCH was Imperial Chemicals Industry (ICI) (United Kingdom). Production ceased around 2007. Lindane and its related isomers alpha-HCH and beta-HCH are listed in Annex A to the Stockholm Convention ("Elimination"), under which there are no specific exemptions for production for any of the three listings.

(c) Use

75. Lindane has been used to treat food crops and forestry products, as a seed treatment and as a soil treatment. Lindane was used as an insecticide on fruit, vegetables, forest crops, animals and animal premises (ATSDR, 2005). With the listing of lindane that entered into force on 26 August 2010, certain uses were exempted for five additional years, namely as a human health pharmaceutical for the treatment of head lice and scabies as a second line treatment. The specific exemptions have expired for all Parties by March 2019. No new registrations may be made with respect to specific exemptions for technical lindane and its related isomers.

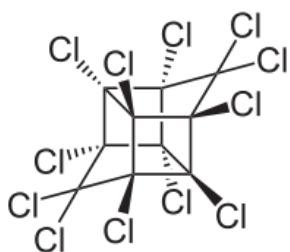
76. Lindane may also be found in formulations with a range of other fungicides and insecticides. It was available as a suspension, emulsifiable concentrate, fumigant, seed treatment, wettable and dustable powder, and ultra low volume (ULV) liquids (Hauzenberger et al., 1990).

77. The alpha-HCH and beta-HCH isomers occurred as by-products in the manufacture of lindane.

¹⁵ Report of the Conference of the Parties of the Stockholm Convention on Persistent Organic Pollutants on the work of its fourth meeting, Geneva, 4-8 May 2009.

(d) Waste

78. Waste HCH can be found in (see paragraph 12 for further details):
- Production wastes. The production of lindane created large amounts of waste containing other isomers of HCH including the alpha and beta isomers. The total quantity of waste was about 8 times the lindane output;
 - Obsolete pesticides, pharmaceuticals and veterinary products;
 - Buried pesticides;
 - Sites where waste has been deposited;
 - Contaminated packaging materials and equipment;
 - Contaminated building materials;
 - Contaminated soil;
 - Contaminated sediment.

11. Mirex**(a) Description****Figure 11:** Structural formula of mirex

79. Mirex (CAS No: 2385-85-5) is a white crystalline substance. It has a melting point of 485°C and is thus fire resistant. The structural formula of mirex is shown in Figure 11 above. Mirex is soluble in several organic solvents, including tetrahydrofuran (30 per cent), carbon disulphide (18 per cent), chloroform (17 per cent) and benzene (12 per cent), but it is nearly insoluble in water. Mirex is considered to be extremely stable (Kaiser, 1978). It does not react with sulphuric, nitric, hydrochloric or other common acids and is unreactive to bases, chlorine and ozone. In the environment, it degrades to photomirex when exposed to sunlight (ATSDR, 1995; IPCS, 1997; EPA, 2000, ATSDR, 2019a).

(b) Production

80. Production of mirex began in the United States of America in 1955 and ceased in that country in 1978, after the chemical was banned. Production and use continued in other regions of the world, however. Mirex is listed in Annex A to the Stockholm Convention (“Elimination”), under which there are no specific exemptions for production of the chemical (previous exemptions have expired).

(c) Use

81. Mirex was most commonly used in the 1960s as an insecticide to control imported fire ants in nine southern states of the United States of America. Mirex was chosen in fire ant eradication programmes because of its effectiveness and selectiveness. It was originally applied aerially at concentrations of 0.3–0.5 per cent. However, aerial applications of mirex were replaced by mound applications because of suspected toxicity to estuarine species and because the goal of fire ant programmes was modified from eradication to selective control. Mirex was also used to control leaf cutter ants in South America, harvester termites in South Africa, mealy bugs in pineapples in Hawaii, and western harvester ants and common (yellow jacket) wasps in the United States of America. All registered products containing mirex were effectively cancelled in the United States of America in December 1977, but selected ground applications were permitted until June 1978, when the product was banned in that country with the exception of Hawaii, where its use on pineapples was allowed to continue until available stocks were exhausted. In the US, about 25% of the mirex produced was used as a pesticide and the remaining 75% was used as an industrial fire retardant additive (ATSDR, 2019a). Many other countries subsequently banned the chemical.

Australia ended its use in 2007 (APVMA, 2006). There are no specific exemptions for use of the chemical (previous exemptions have expired) for mirex under the Stockholm Convention.

(d) Waste

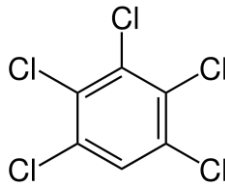
82. Waste mirex can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated soil;
- (h) Contaminated sediment.

12. Pentachlorobenzene (PeCB)

(a) Description

Figure 12: Structural formula of pentachlorobenzene



83. Pentachlorobenzene (PeCB) (CAS No: 608-93-5) belongs to the group of chlorobenzenes. The structural formula of PeCB is shown in Figure 12 above. PeCB has been used as a pesticide in the past and it is not clear whether this use has continued. PeCB can be present as an impurity in some organochlorine solvents and pesticides, including pentachloronitrobenzene (quintozene), clopyralid, atrazine, chlorothalonil, dacthal, lindane, pentachlorophenol, picloram and simazine, and is used as an intermediate product to manufacture pentachloronitrobenzene pesticide (hereinafter referred to as “quintozene”). Impurities and contaminants are considered to be unintentionally produced, so the Parties should seek guidance regarding their ESM in the unintentional POPs technical guidelines (UNEP, 2017).

(b) Production

84. PeCB is used to make the fungicide quintozene. Production of PeCB as a pesticide ceased in the 1990s.

85. PeCB is no longer produced commercially in the member States of the United Nations Economic Commission for Europe (UNECE) (Belfroid et al., 2005). Major United States of America and European manufacturers of quintozene have changed their manufacturing process to eliminate the use of PeCB. The use of quintozene has ceased in most UNECE member States. PeCB is listed in Annex A to the Stockholm Convention (“Elimination”), under which and there are no specific exemptions for production of the chemical.

86. The situation regarding production in other countries is unclear. Canada has reported that PeCB is not produced in the country but is present as an impurity in the fungicide quintozene and in several herbicides, pesticides and fungicides currently in use in Canada. The United States of America has reported that PeCB was formerly used in the production of quintozene, but there is no information on current production of quintozene in the United States of America.

(c) Use

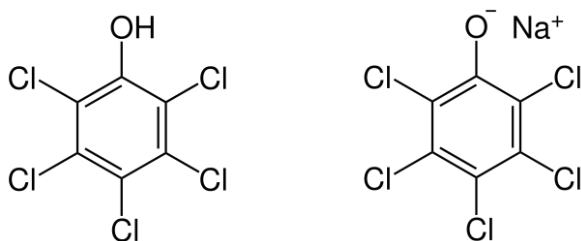
87. PeCB is present as an impurity in commercial pesticides which are still used in Europe, Canada and the United States of America, and it is unclear whether it is used as a pesticide in other parts of the world. There are no specific exemptions for use of the chemical under the Stockholm Convention for this chemical.

(d) Waste

88. Waste PeCB can be found in (see paragraph 12 for further details):
- Production wastes;
 - Obsolete pesticides;
 - Buried pesticides;
 - Sites where waste has been deposited;
 - Contaminated packaging materials and equipment;
 - Contaminated building materials;
 - Contaminated sewage sludge;
 - Contaminated soil;
 - Contaminated sediment.

13. Pentachlorophenol and its salts**(a) Description**

Figure 13: Structural formulas of pentachlorophenol (PCP, left) and its sodium salt, i.e. sodium pentachlorophenate (right)



89. Pentachlorophenol (PCP) is a chlorinated aromatic hydrocarbon of the chlorophenol family, consisting of a chlorinated benzene ring and hydroxyl group. The structural formulas of PCP and its salt Na-PCP is shown in Figure 13 above. PCP and its salts and esters cover pentachlorophenol (PCP, CAS No: 87-86-5), sodium pentachlorophenate (Na-PCP, CAS No: 131-52-2 and 27735-64-4 (as monohydrate)) and pentachlorophenyl laurate (PCP-L, CAS No: 3772-94-9), when considered together with their transformation product pentachloroanisole (PCA, CAS No: 1825-21-4), according to decision SC-7/13 of the Conference of the Parties to the Stockholm Convention. The ester PCP-L has no pesticide use, and is therefore not covered here.

90. Pure PCP consists of light tan to white, needle-like crystals and is relatively volatile. Technical grade PCP is typically about 86% pure (Institute of Environmental Protection, 2008). The technical grade PCP formulation currently used in Canada consists of 86% PCP, 10% other chlorophenols and related compounds and 4% inerts (Environment Canada, 2013). PCP and Na-PCP have been available in form of solid blocks, flakes, granulate, powder or as a dilutable liquid (UNEP/POPS/POPRC.9/13/Add.3; German Federal Environment Agency, 2015).

(b) Production

91. Commercial significance has been reported since 1950's and 1960's (Environment Canada, 2013; Swedish Environmental Protection Agency, 2009; USWAG, 2008; Kitunen, 1990). Since then, use has been restricted in many countries and the production is significantly lower (UNEP/POPS/POPRC.10/10/Add.1).

92. PCP is currently manufactured at least in Mexico and formulated in the U.S. The main share of the PCP market and use is in North America (UNEP/POPS/POPRC.10/10/Add.1). Na-PCP was produced in India (ICC, 2014). PCP or Na-PCP have earlier been produced at least in Brazil, China, former Czechoslovakia, Denmark, France, Germany, Poland, Spain, Switzerland, former USSR, and the United Kingdom. In the EU-10 the production stopped in 1992. China produced PCP at least until 2003 (Zheng et al., 2012), but not anymore in 2014 (China, 2014).

93. Annex A to the Stockholm Convention contains a specific exemption for production of the chemical for Parties registered in the register of specific exemptions, for use in utility poles and cross-arms.

(c) Use

94. As a pesticide PCP was used both as a general pre-emergence herbicide for weed control and as a defoliant, fungicide, pre-harvest desiccant, bactericide, insecticide, molluscicide and termiticide. In China, PCP and its salt Na-PCP was primarily used to kill schistosome intermediate host snails; about 60% of the national production was applied for this purpose (Zheng et al., 2012). The non/agricultural use included uses along drainage ditches, driveways, and fencerows (EXTOXNET). In the United States of America, application of PCP in the home as a pesticide (and herbicide) accounted for only 3% of its consumption in the 1970s (ATSDR, 2001). In the former USSR, PCP was applied as a nonselective herbicide and as a desiccant on cotton plants (WHO, 1987).

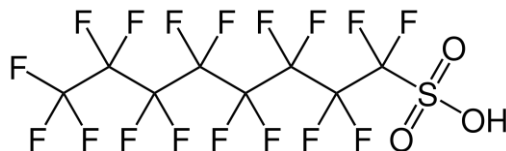
(d) Waste

95. Waste PCP and Na-PCP pesticides can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated sewage sludge;
- (h) Contaminated soil;
- (i) Contaminated sediment;
- (j) Contaminated water;
- (k) Preserved materials.

14. Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOF)**(a) Description**

Figure 14: Structural formula of PFOS



96. PFOS belongs to the family of perfluoroalkyl substances (PFASs). PFOS, its salts and perfluorooctane sulfonyl fluoride are covered by the PFOS and PFOA technical guidelines (UNEP, XXXX). The structural formula of PFOS is shown in Figure 14 above.

97. N-Ethyl perfluorooctane sulfonamide (EtFOSA; sulfluramid; CAS No: 4151-50-2) has been used as a surfactant and an active ingredient in ant baits to control leaf-cutting ants from *Atta spp.* and *Acromyrmex spp.* in many countries in South America as well as for control of red imported fire ants, and termites. Sulfluramid can still be used in insect baits for control of leaf-cutting ants for agricultural use only, in accordance with an acceptable purpose. About 10% might degrade to PFOS, and sulfluramid use represents a direct release of PFOS to the environment (UNEP/POPS/POPRC.12/INF/15/Rev.1). Only surfactant and pesticide uses of sulfluramid are covered in the present guidelines (see also paragraph 5 of the present guidelines). In addition, lithium salt of PFOS (CAS No: 29457-72-5, trade names Sulfofine, RAID TVK), has been historically used in the formulation of wasp/hornet bait stations (US EPA, 1999).

98. Fluorosurfactants may also be used as “inert” surfactants (enhancers) in pesticide products. Two PFOS-related substances potassium N-ethyl-N-[(heptadecafluorooctyl) sulfonyl] glycinate (CAS No: 2991-51-7) and 3-[[[(heptadecafluorooctyl)sulfonyl]amino]-N,N,N-trimethyl 1-propanaminium iodide (CAS No: 1652-63-7) have been approved in pesticide formulations in the United States of America. Both chemicals have other uses, for example as cleaning agents (UNEP-POPS-POPRC.12-INF-15-Rev.1). PFOS derivatives were used in pesticides because they were considered rather inert and non-toxic (UNIDO, 2012).

(b) Production

99. PFOS, its salts and PFOSF are listed on Annex B (“Restriction”) to the Stockholm Convention. Brazil and Viet Nam have made production notifications for insect baits for control of leaf-cutting ants from *Atta spp.* and *Acromyrmex spp.* According to the decision SC-9/4 that entered into force on 3 December 2020, PFOS, its salts and PFOSF production will be limited to only insect baits for control of leaf-cutting ants for agricultural use only. Production of PFOS, its salts and PFOSF for use in control of red imported fire ants and termites is no longer possible under the Convention.

100. Sulfluramid is produced by electrochemical fluorination with PFOSF as an intermediate. For further details, see PFOS and PFOA technical guidelines (UNEP, XXXX) and Guidance on best available techniques and best environmental practices for the use of perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF), perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds listed under the Stockholm Convention on Persistent Organic Pollutants (UNEP, 202X).

(c) Use

101. The amendment listing PFOS in Annex B to the Stockholm Convention, which entered into force on 26 August 2010, included acceptable purposes and specific exemptions for certain uses. As of 3 December 2020, insect baits with sulfluramid (CAS No: 4151-50-2) as an active ingredient for control of leaf-cutting ants from *Atta spp.* and *Acromyrmex spp.* for agricultural use only are listed as acceptable purpose for the production and use of PFOS, its salts and PFOSF. The specific exemption for the use of PFOS, its salts and PFOSF for insecticides for the control of red imported fire ants and termites is no longer available under the Convention.

102. Sulfluramid is formulated as granular baits which contain 0.3% sulfluramide, fruit pulp (usually from oranges) and vegetable oil. According to information from the 2006 OECD survey sulfluramid was used in insecticides at a concentration of 0.01-1% at an annual volume of up to 17 tonnes (OECD, 2006). Baits are directly distributed from their packaging, with no manual contact, close to active nest entrance holes or anthill trails and carried into the colony by the ants themselves. (UNEP/POPS/POPRC.12/INF/15/REV.1).

103. Brazil and Vietnam have notified the Secretariat on the use of PFOSF to produce sulfluramid as an active ingredient for the production of bait to control leaf-cutting ants in 2010 and 2013, respectively. The insect baits for control of leaf-cutting ants are also used in Argentina, Belize, Bolivia, Ecuador, Mexico and Nicaragua; and use is reported in Antigua and Barbuda, Chile, Columbia, Dominican Republic, El Salvador, Guatemala, Honduras, Panama, Paraguay, Peru, Suriname and Uruguay, and in Federated States of Micronesia and French Polynesia (Watts, 2016, UNEP/POPS/POPRC.12/INF/15). In the EU, PFOS-related substances are not used in the manufacture of pesticides, and the US EPA cancelled the manufacturing use-registration of sulfluramid in May 2008 and all product registrations by 2012 (UNEP/POPS/POPRC.12/INF/15).

(d) Waste

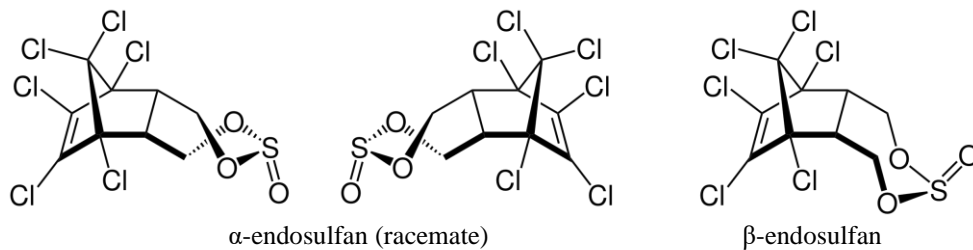
104. Waste from pesticides, which are produced using PFOSF or which may contribute to PFOS releases into the environment, can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides, including granular ant baits and wasp/hornet bait stations;
- (c) Buried pesticides;
- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated sewage sludge;
- (h) Contaminated soil;
- (i) Contaminated sediment;
- (j) Contaminated water.

15. Technical endosulfan and its related isomers

(a) Description

Figure 15: Structural formula of α - and β -endosulfan isomers



105. Technical endosulfan (CAS No: 115-29-7) is a chlorinated cyclodiene pesticide. Technical endosulfan is a 7:3 mixture of stereoisomers, designated α (CAS No: 959-98-8) and β (CAS No: 33213-65-9). α - and β -Endosulfan are conformational isomers arising from the pyramidal stereochemistry of sulfur. The structural formulas of endosulfan isomers are shown in Figure 15 above. α -Endosulfan is the more thermodynamically stable of the two, thus β -endosulfan irreversibly converts to the α form, although the conversion is slow. Endosulfan is volatile, persistent, and has the potential to bioaccumulate in aquatic and terrestrial organisms. It is a cream-to-brown-colored solid that may appear crystalline or in flakes (ATSDR, 2015b).

(b) Production

106. The original patent holder and producer was Bayer AG. Endosulfan was placed on the market in the 1950s by Farbwerke Hoechst A.G. in Frankfurt, Germany (now Bayer) and FMC Corporation in the United States of America (Janssen, 2011). With the listing of endosulfan and its related isomers in Annex A to the Stockholm Convention (“Elimination”) that entered into force on 27 October 2012, production for certain uses was exempted for five additional years. All registrations for specific exemptions for production of endosulfan have expired by 2019. No new registrations may be made with respect to specific exemptions for technical endosulfan and its related isomers.

(c) Use

107. With the listing of endosulfan and its related isomers in Annex A to the Stockholm Convention (“Elimination”) that entered into force on 27 October 2012, certain uses were exempted for five additional years. All registrations for specific exemptions for use of endosulfan have expired by 2019.. No new registrations may be made with respect to specific exemptions for technical endosulfan and its related isomers..

108. An organochlorine insecticide first registered in the 1950s, endosulfan was used on a variety of vegetables and fruits, on cotton and on ornamental plants. Endosulfan has no residential uses. Crops with the highest use in 2006, 2007 and 2008 included apple, cotton, cucurbit (cucumber, pumpkin, summer squash, winter squash), pear, potato and tomato. Endosulfan has been used in agriculture around the world to control insect pests including whiteflies, aphids, leafhoppers, Colorado potato beetles and cabbage worms (BiPro, 2010). China registered exemption for use on cotton and tobacco and Zambia for use on tea, bean, cowpea, cotton, eggplant, groundnut, maize, mango, onion, okra, potato, rice, tea, tobacco, tomato and wheat.

109. Endosulfan was formulated into both liquid and solid products. The most common liquid formulations were emulsifiable concentrates and ULV both of which often include flammable solvents in their ingredients. The common solid formulations were wettable powders and smoke tablets. Endosulfan is compatible with many other pesticide active ingredients and may be found in formulations with dimethoate, malathion, methomyl, monocrotophos, pirimicarb, triazophos, fenoprop, parathion, petroleum oils, and oxine-copper. It is not compatible with alkaline materials.

(d) Waste

110. Waste endosulfan can be found in (see paragraph 12 for further details):

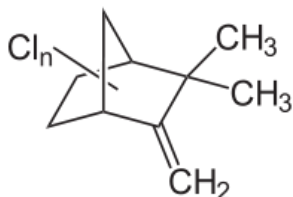
- (a) Production wastes;
- (b) Obsolete pesticides;
- (c) Buried pesticides;

- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated sewage sludge;
- (h) Contaminated soil;
- (i) Contaminated sediment;
- (j) Contaminated water.

16. Toxaphene

(a) Description

Figure 16: Structural formula of toxaphene



111. Toxaphene (CAS No: 8001-35-2) is an insecticide containing over 670 polychlorinated bicyclic terpenes consisting predominantly of chlorinated camphenes. The structural formula of toxaphene is shown in Figure 16 above. Toxaphene formulations included wetttable powders, emulsifiable concentrates, dusts, granules, baits, oils and emulsions (IARC, 1979; ATSDR, 2014). In its original form, toxaphene is a yellow to amber waxy solid that smells like turpentine (see below). Its melting point ranges from 65°C to 90°C, while its boiling point in water is above 120°C, which is the temperature at which toxaphene starts to decompose. Toxaphene tends to evaporate when in solid form or when mixed with liquids, and it does not burn. Toxaphene is the trade name for camphechlor, chlorocamphene, polychlorocamphene and chlorinated camphene or norbornanes (ATSDR, 2014; Fiedler et al., 2000; IPCS INCHEM, no year; EPA, 2000b).

(b) Production

112. Toxaphene was first produced commercially in 1947 in the United States of America by Hercules Powder Company. It was once the most heavily manufactured pesticide in the United States of America, with a maximum production volume of 23,000 tonnes in 1973 (ATSDR, 2014; Fiedler et al., 2000). It is no longer produced. Toxaphene is listed in Annex A to the Stockholm Convention (“Elimination”), under which there are no specific exemptions for production of the chemical.

(c) Use

113. Toxaphene was the most popular substitute after DDT was banned from use in the United States in 1972, and one of the most heavily used insecticides in the United States of America until 1982, when most of its uses were banned. All uses were banned in 1990. Because toxaphene was found to be less toxic to bees than arsenical insecticides, it was largely used as a non-systemic stomach and contact insecticide on cotton, corn, fruit, vegetables and small grains, as well as soybeans. Toxaphene was also used to control livestock ectoparasites such as lice, flies, ticks, mange and scab mites. Its use increased from the late 1960s to the early 1970s, when it replaced DDT in formulations combined with methyl parathion. It has been estimated that 1.3 million tonnes of toxaphene were used globally from 1950 to 1993 (Voldner and Li, 1993). Through the early 1970s, toxaphene or mixtures of toxaphene and rotenone were used widely by fish and game agencies in lakes and streams to eliminate biologic communities that were considered undesirable in sport fishing (ATSDR, 2014; Fiedler et al., 2000). There are no specific use exemptions for toxaphene under the Stockholm Convention.

(d) Waste

114. Waste toxaphene can be found in (see paragraph 12 for further details):

- (a) Production wastes;
- (b) Obsolete pesticides and veterinary products;
- (c) Buried pesticides;

- (d) Sites where waste has been deposited;
- (e) Contaminated packaging materials and equipment;
- (f) Contaminated building materials;
- (g) Contaminated sewage sludge;
- (h) Contaminated soil;
- (i) Contaminated sediment;
- (j) Contaminated water.

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

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

116. Annex I lists some of the wastes that may consist of, contain or be contaminated with pesticide POPs (i.e., pesticide POPs wastes) or with HCB as an industrial chemical:

- (a) Pesticide POPs wastes could include:
 - Y2: Wastes from the production and preparation of pharmaceutical products
 - Y4: Wastes from the production, formulation and use of biocides and phytopharmaceuticals
 - Y5: Wastes from the manufacture, formulation and use of wood preserving chemicals
 - Y6: Wastes from the production, formulation and use of organic solvents
 - Y15: Wastes of an explosive nature not subject to other legislation
 - Y18: Residues arising from industrial waste disposal operations
 - Y39: Phenols, phenol compounds including chlorophenols
 - Y45: Organohalogen compounds other than substances referred to in [Annex I] (e.g., Y39, Y41, Y42, Y43, Y44)
- (b) Waste HCB as an industrial chemical could include:
 - Y5: Wastes from the manufacture, formulation and use of wood preserving chemicals
 - Y6: Wastes from the production, formulation and use of organic solvents
 - Y15: Wastes of an explosive nature not subject to other legislation
 - Y41: Halogenated organic solvents
 - Y43: Any congener of polychlorinated dibenzo-furan
 - Y44: Any congener of polychlorinated dibenzo-*p*-dioxin

117. Wastes listed in Annex I are presumed to exhibit one or more Annex III hazardous characteristic, which may include H11 “Toxic (Delayed or chronic)”, H12 “Ecotoxic”, or H6.1 “Poisonous (Acute)”, unless, through “national tests”, they can be shown not to exhibit such characteristics. National tests may be useful for identifying a particular hazardous characteristic listed in Annex III until such time as the hazardous characteristic is fully defined. Guidance papers for Annex III hazardous characteristics H11, H12 and H13 were adopted on an interim basis by the Conference of the Parties to the Basel Convention at its sixth and seventh meetings.

118. List A of Annex VIII describes wastes that are “characterized as hazardous under Article 1, paragraph 1 (a), of this Convention” although “their designation on this Annex does not

preclude the use of Annex III [hazard characteristics] to demonstrate that a waste is not hazardous” (Annex I, paragraph (b)).

119. The following Annex VIII waste categories are applicable to pesticide POPs and to HCB as an industrial chemical:

- (a) With regard to pesticide POPs, the waste categories include:
- A3070: Waste phenols, phenol compounds including chlorophenol in the form of liquids or sludges
 - A3210: Plastic waste, including mixtures of such waste, containing or contaminated with Annex I constituents, to an extent that it exhibits an Annex III characteristic (note the related entries Y48 in Annex II and on list B B3011);
 - A4010: Wastes from the production, preparation and use of pharmaceutical products but excluding such wastes specified on list B
 - A4030: Wastes from the production, formulation and use of biocides and phytopharmaceuticals, including waste pesticides and herbicides which are off-specification, outdated,¹⁶ or unfit for their originally intended use
 - A4040: Wastes from the manufacture, formulation and use of wood-preserving chemicals¹⁷
 - A4080: Wastes of an explosive nature (but excluding such wastes specified on list B)
- (b) With regard to HCB as an industrial chemical, the waste categories include:
- A4070: Wastes from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding any such waste specified on list B (note the related entry on list B B4010)¹⁸
 - A4080: Wastes of an explosive nature (but excluding such wastes specified on list B)

120. Annex VIII includes a number of wastes and waste categories that have the potential to contain or be contaminated with:

- (a) Pesticide POPs resulting from past applications of those substances, such as:
- A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics
 - A4140: Wastes consisting of or containing off specification or outdated chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics
- (b) HCB as an industrial chemical resulting from past applications of that substance, such as:
- A4110: Wastes that contain, consist of or are contaminated with any of the following:
 - Any congener of polychlorinated dibenzo-furan
 - Any congener of polychlorinated dibenzo-*p*-dioxin
 - A4130: Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics

121. List B of Annex IX lists wastes that “will not be wastes covered by Article 1, paragraph 1 (a), of this Convention unless they contain Annex I material to an extent causing them to exhibit an Annex III characteristic.” List B of Annex IX includes a number of wastes or waste categories

¹⁶ “Outdated” means unused within the period recommended by the manufacturer.

¹⁷ This entry does not include wood treated with wood-preserving chemicals.

¹⁸ B4010: Wastes consisting mainly of water-based/latex paints, inks and hardened varnishes not containing organic solvents, heavy metals or biocides to an extent to render them hazardous.

that have the potential to contain or be contaminated with pesticide POPs and HCB as an industrial chemical, including:

- (a) B1010: Metal and metal-alloy wastes in metallic, non-dispersible form,¹⁹ in particular:
 - Iron and steel scrap; and
 - Aluminium scrap.
- (b) B1050: Mixed non-ferrous metal, heavy fraction scrap, not containing Annex I materials in concentrations sufficient to exhibit Annex III characteristics;
- (c) B2040: Other wastes containing principally inorganic constituents²⁰ in particular:
 - Waste gypsum wallboard or plasterboard arising from the demolition of buildings;
 - broken concrete.
- (d) B2060: Spent activated carbon not containing any Annex I constituents to the extent they exhibit Annex III characteristics, for example, carbon resulting from the treatment of potable water and processes of the food industry and vitamin production (note the related entry on list A A4160);
- (e) B3011: Plastic waste (note the related entries Y48 in Annex II and on list A3210)²¹;
- (f) B3020: Paper, paperboard and paper product wastes²²;
- (g) B3030: Textile waste²³;
- (h) B3050: Untreated cork and wood waste.²⁴

122. Annex II lists some of waste categories that have the potential to contain or be contaminated with pesticide POPs:

- (a) Y46: Wastes collected from households;
- (b) Y48: Plastic waste, including mixtures of such waste, with the exception of the following:²⁵

123. For further information, see section II.A of the General technical guidelines.

B. Stockholm Convention

124. For HCB, HCBd, PCP and its salts and esters, and PFOS, its salts and PFOSE, note (iii) of Annex A sets forth a further procedure under which a Party to the Stockholm Convention may give notification of its production and use as a closed-system site-limited intermediate. Such production or use is not considered a production or use specific exemption. Such production and use must cease after a 10-year period unless the Party concerned submits a new notification, in which case the production and use may be extended for an additional 10 years unless the Conference of the Parties, after a review of the production and use, decides otherwise. The notification procedure can be repeated.

125. For further information, see section II.B.2 of the General technical guidelines.

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

A. Low POP content

126. The provisional definition of low POP content for aldrin, chlordane, chlordecone, dieldrin, endrin, heptachlor, HCB, mirex, PeCB, PFOS, technical endosulfan and its related isomers and toxaphene is 50 mg/kg for each. The provisional definition of low POP content for alpha-HCH,

¹⁹ Refer to Annex IX to the Basel Convention to see the full entry.

²⁰ *Ibid.*

²¹ *Ibid.* 31.

²² *Ibid.* 31.

²³ *Ibid.* 31.

²⁴ *Ibid.* 31.

²⁵ Refer to Annex IX to the Basel Convention for a full description of this entry.

beta-HCH and lindane is 50 mg/kg as a sum²⁶. The provisional definition of low POP content for HCBd is 100 mg/kg. The provisional definition of low POP content for PCP and its salts and esters is 100 mg/kg. The provisional definition for low POP content for dicofol is [50] mg/kg.

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

128. Wastes with a content of:

- (a) aldrin, chlordane, chlordecone, dieldrin, endrin, heptachlor, HCB, mirex, PeCB, PFOS, technical endosulfan and its related isomers, toxaphene or the sum of alpha-HCH, beta-HCH and lindane at or above 50 mg/kg;
- (b) HCBd at or above 100 mg/kg;
- (c) PCP and its salts and esters at or above 100 mg/kg
- (d) Dicofol at or above 50 mg/kg;

must be disposed of in such a way that the POP content is destroyed or irreversibly transformed according to the methods described in section IV.G.2. They should otherwise be disposed of in an environmentally sound manner when destruction or irreversible transformation does not represent the environmentally preferable option according to the methods described in section IV.G.3.

129. Wastes with a content of:

- (a) aldrin, chlordane, chlordecone, dieldrin, endrin, heptachlor, HCB, mirex, PeCB, PFOS, technical endosulfan and its related isomers, toxaphene or the sum of alpha-HCH, beta-HCH and lindane below 50 mg/kg;
- (b) HCBd below 100 mg/kg;
- (c) PCP and its salts and esters below 100 mg/kg;
- (d) Dicofol below 50 mg/kg;

should be disposed of in accordance with the methods referred to in section IV.G.4.

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

B. Levels of destruction and irreversible transformation

131. For a 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

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

IV. Guidance on environmentally sound management (ESM)

A. General considerations

133. See subsection IV.A of the General technical guidelines.

B. Legislative and regulatory framework

134. The Parties to the Basel and Stockholm conventions should examine their national strategies, policies, controls and procedures to ensure that they are in agreement with the two conventions and with their obligations under them, including those that pertain to ESM of pesticide POPs wastes.

135. Regulatory frameworks applicable to pesticide POPs should include measures to prevent the generation of wastes and measures to ensure ESM of those wastes that are generated. Such measures and controls could include the following:

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

²⁶ The limit value has been set for the sum of lindane and its by-products alpha- and beta-HCH, because all three together may be contained in pesticides and production wastes.

- (b) Prohibitions on the production, sale, use, import and export of pesticide POPs;
- (c) Phase-out dates for pesticide POPs that are in use or in stock;
- (d) Transportation requirements for hazardous materials and waste;
- (e) Specifications for containers, equipment, bulk containers and storage sites;²⁷
- (f) Specification of acceptable analytical and sampling methods for pesticide POPs;
- (g) Requirements for waste management and disposal facilities;
- (h) Definitions of hazardous waste, and conditions and criteria for the identification and classification of pesticide POPs wastes as hazardous wastes;
- (i) A general requirement for public notification and review of proposed government regulations, policy, certificates of approval, licences, inventory information and national releases data;
- (j) Requirements concerning the identification, assessment and remediation of contaminated sites;
- (k) Requirements concerning the health and safety of workers;
- (l) Other legislative measures on, e.g., waste prevention and minimization, inventory development and emergency response.

136. Legislation should establish a link between the phase-out dates for the production and use of pesticide POPs (including in products and articles) and the disposal of such pesticide POPs once they have become waste. Legislation should also include a time limit for the disposal of pesticide POPs wastes so as to prevent the creation of stockpiles that have no clear phase-out dates.

137. For further information, see section IV.B of the General technical guidelines.

C. Waste prevention and minimization

138. Both the Basel and Stockholm conventions advocate waste prevention and minimization, while pesticide POPs listed in Annex A to the Stockholm Convention are targeted for complete elimination. Accordingly, pesticide POPs should be taken out of service and disposed of in an environmentally sound manner. Governments could require pesticide producers, formulators and users of products and articles containing pesticide POPs to develop waste management plans for all hazardous waste, including pesticide POPs wastes.

139. Quantities of waste containing pesticide POPs should be prevented and minimized through isolation and source separation in order to prevent mixing with and contamination of other waste streams or environmental resources (air, water and soil). For example, at those locations where pesticide POPs are directly leaking from unstable containers that have deteriorated, risk of further damage to the environment and the population should be minimized as soon as possible. The following options should be considered:

- (a) Stabilization of the site: leaking pesticides should be segregated and repacked;
- (b) Reduction of the number of pesticide POPs storage sites to a limited number of centralized storage sites and repackaging of pesticide POPs for safe storage at those centralized sites. High quantities of hazardous waste on the same site may require additional measures to prevent serious environmental accidents.

140. The mixing and blending of wastes with a pesticide POP content above the low POP content defined in paragraph 128 above with other materials solely for the purpose of generating a mixture with a POP content below the defined low POP content is not environmentally sound. Nevertheless, the mixing or blending of materials before waste treatment may be necessary in order to enable treatment or to optimize treatment efficiency.

141. For further information, see section IV.C of the General technical guidelines.

²⁷ Parties should consult the guidelines pertaining to the storage of pesticides and pesticide waste that have been produced by the Food and Agriculture Organization (FAO) of the United Nations (FAO, 1996).

D. Identification of wastes

142. 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 pesticide POPs wastes is the starting point for their effective ESM.

143. For general information on identification of waste, see section IV.D of the General technical guidelines.

1. Identification

144. The identification of pesticide POPs, which is an obligation under the Stockholm Convention, should not be considered an isolated activity. It is highly recommended that when engaging in efforts to identify the pesticide POPs covered in the present technical guidelines the Parties also seek to identify DDT and other obsolete pesticides so as to ensure that the wider problem of obsolete pesticides is addressed. The experience of Africa indicates that between 15 per cent and 30 per cent of obsolete pesticides may be pesticide POPs (ASP, 2004).

145. Pesticide POPs, except HCB as an industrial chemical, are typically found:

- (a) In residues from pesticide POPs production and at sites where such pesticides were produced, formulated and stored;
- (b) In government storage under health and agriculture ministries;
- (c) In storage facilities and at sites where pesticides were deployed or applied, e.g., at air strips where aerial sprayers were refilled;
- (d) In homes (domestic storage), outlets for drugs and pesticides, shopping centres, schools, hospitals, industrial facilities, office and apartment buildings, etc.;
- (e) In contaminated materials, including protective clothing, application equipment and accessories, empty packaging materials, containers, floors, walls and windows;
- (f) At dumpsites and in landfills;
- (g) In soils, sediments and sewage sludges and in water that has been contaminated by, for example, spills, runoff and leaching;
- (h) Residues in food;
- (i) In commercial products containing pesticide POPs, such as paints, household insect sprays, mosquito coils and mosquito nets.

146. HCB as an industrial chemical is typically found:

- (a) At manufacturing plants that produce HCB;
- (b) In wastes present or generated in manufacturing plants that formerly produced HCB, as described in subsection I.B.7 above;
- (c) In wastes present or generated in manufacturing plants that use or previously used HCB for the uses described in paragraph 62, subparagraph (a), above;
- (d) In wastes present or generated in manufacturing plants that use or previously used HCB as a chemical intermediate in the manufacture of the chemicals discussed in paragraph 62, subparagraph (b) above.

147. It should be noted that, normally, experienced and well trained technical persons will be able to determine the nature of an effluent, substance, container or piece of equipment by its appearance or markings. In many countries, however, large stocks of unidentified agricultural chemicals exist. Experienced inspectors may be able to determine the original contents from information on the container labels, the type and colour of the original containers or by smell or appearance of the chemical (colour, physical characteristics). Accurate identification and determination of the level of contamination in a sample through chemical analysis is especially needed for sound environmental management. In identifying pesticide POPs, the common trade names listed in annex I of this document may be found useful.

2. Inventories

148. It is advisable to refer to the FAO tools including “The Preparation of Inventories of Pesticides and Contaminated Materials” (FAO, 2010). This tool recommends that when

undertaking inventories, all pesticide stocks should be included, not just POPs. Other obsolete pesticides pose significant risk to public health and the environment and should be addressed in any strategies for the risk reduction of obsolete pesticides. A complete inventory of pesticide POPs may be very difficult to compile, mainly because of the dispersed nature of the uses and storage of these chemicals over broad rural and urban areas. In that connection, national and local governments responsible for pesticides and pesticide wastes may be able to provide valuable assistance.

149. In developing inventories it should be borne in mind that equal effort should be devoted to ensuring both the completeness and the integrity of the inventories. If inventories are detailed, the integrity of inventoried stock should be secured so that any addition to or removal from the stock is known, and so that contamination of or mixing with other materials is prevented. Inventories should also provide summaries and categories of possible final disposal destinations for pesticide POPs (see, for example, UNEP, 2001).

E. Sampling, analysis and monitoring

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

1. Sampling

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

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

153. Types of matrices typically sampled for pesticides and pesticide-related wastes include:

- (a) Liquids:
 - (i) Liquid pesticide formulations;
 - (ii) Leachates from burials and landfills;
 - (iii) Biological fluids (blood, in the case of worker health monitoring);
- (b) Solids:
 - (i) Solid pesticide formulations and pesticide production wastes;
 - (ii) Soils, sediments and municipal and industrial sludges;
 - (iii) Packaging;
 - (iv) Building materials.

2. Analysis

154. Most pesticides can be analysed using capillary gas chromatography (two columns of different polarity) coupled to an electron captor detector (ECD). For toxaphene, mass selective detectors have to be used (operating in NCI mode). The analysis of dicofol is affected by several difficulties, which should be considered when evaluating the reliability of study results. LC-MS/MS sensitivity for dicofol is very poor and the compound is thus typically analyzed via GC (e.g. using ECD, MSD or MS/MS) (UNEP/POPS/POPRC.12/11/Add.1). Dicofol degrades thermally quickly in GC/MS analysis and its limit of quantification may be higher than that of other pesticides. A procedure for dicofol analysis in water has been described in German Federal Environment Agency (2008) and European Commission (2019). Dicofol can be analysed using capillary gas chromatography or tandem mass spectrometry from various matrices (CEN/TR 16699 and EN 12393-2). PFOS and precursors require a combination of liquid chromatograph to preferentially tandem mass spectrometers (see PFOS and PFOA technical guidelines (UNEP, 2022)).

3. Monitoring

155. Monitoring programmes should be implemented for facilities managing wastes consisting of, containing or contaminated with pesticide POPs.

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

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

1. Handling

157. The main concerns when handling pesticide POPs wastes are human exposure, accidental releases to the environment and contamination of other waste streams with pesticide POPs. Pesticide POPs wastes should be handled separately from other waste types in order to prevent contamination of other waste streams. Recommended practices towards that end that should be verified, supervised and monitored include:

- (a) Inspecting containers for leaks, holes, rust, high temperatures (resulting from chemical reactions) and appropriate repackaging of the wastes, as necessary;
- (b) Handling wastes at temperatures below 25°C, if possible, due to increased volatility at temperatures higher than 25°C;
- (c) Ensuring that spill containment measures are in good condition and are adequate to contain liquid wastes if spilled, i.e., that they can hold an additional 10 per cent of the total waste volume;
- (d) Placing plastic sheeting or absorbent mats under containers before opening them if the surface of the containment area is not coated with an impermeable surface material (e.g., paint, polymers or polymeric resin);
- (e) Removing liquid wastes either by removing the drain plug or by pumping the wastes with a peristaltic pump (safeguarded against ignition and fire risk) and suitable chemical-resistant tubing;
- (f) Using dedicated pumps, tubing and drums, not used for any other purpose, to transfer liquid wastes;
- (g) Cleaning up all spills with cloths, paper towels or specific absorbent materials;
- (h) Triple rinsing contaminated empty packaging materials (such as metal drums) with an organic solvent such as kerosene to remove all residual pesticide POPs so that the rinsed containers can be recycled;
- (i) Treating as pesticide wastes all contaminated solvents (i.e., waste solvents from triple rinsing), absorbent materials, disposable protective equipment and plastic sheeting.

158. Staff should be trained in the correct methods for handling hazardous wastes using national or international methods and standards and following FAO guidelines, in particular the Environmental Management Tool Kit for Obsolete Pesticides, volumes 1-4 (FAO, 2009a, 2009b, 2011a, and 2011b).

2. Collection

159. A significant fraction of total national inventories of pesticide POPs may be held in small quantities at small storage sites belonging to farmer cooperatives, distributors, business owners and homeowners. It may be difficult for small-quantity owners to dispose of those materials. For example, logistical considerations may prevent or discourage pick-up (e.g., no hazardous waste pick-up or suitable disposal facility are available in a given country), or pick-up costs may be prohibitive. In some countries, national, regional and municipal governments may wish to consider establishing collection stations for small quantities of pesticides POPs so that each small-quantity owner does not have to make individual transport and disposal arrangements.

160. Pesticide POPs collection depots and collection activities should be managed according to appropriate guidelines and, if necessary, separately from those for all other wastes.

161. It is imperative that collection depots do not become long-term storage facilities for pesticide POPs wastes.

3. Packaging, labelling and transportation

162. Packaging, labelling and transportation of hazardous wastes is regulated both under national and international regulations. Applicable regulations depend on the mode of transport being used, as is shown in table 2 **Error! Reference source not found.:**

Table 2: International Regulations for the Transport of Hazardous Materials

Mode of Transport	Relevant Guideline or Regulation
Air	The Convention on International Civil Aviation, Annex 18 (The Safe Transport of Dangerous Goods by Air) (ICAO)
Road	European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)
Rail	Regulation Concerning the International Carriage of Dangerous Goods by Rail (RID)
Sea	International Maritime Dangerous Goods Code (IMDG)
Inland sea	European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)

163. Detailed guidance on packaging, labelling and transportation is specific to the nature of each pesticide POPs waste, the other ingredients or contaminants that may be present in a given formulation, and the type of waste matrix containing the pesticide POP. Specific guidance on the practicalities of packaging, labelling and transportation is contained in the FAO Environmental Management Tool Kit for Obsolete Pesticides, volumes 1-4 (FAO, 2009a, 2009b, 2011a and 2011b), and in the detailed guidance provided by in the transport regulations and guidelines listed in table 2 **Error! Reference source not found.**

164. Wastes should be properly packaged before storage or transport:

(a) Liquid and solid wastes should be placed in UN standard packaging materials approved for the particular substance being carried in accordance with the requirements for the most highly regulated mode of transport being used;

(b) Organizations responsible for repackaging the waste matrix should take into consideration chemical hazards other than its toxicity, such as its flammability, corrosivity or the environmentally hazards it poses, to ensure that wastes are properly repackaged according to relevant transport guidelines;

(c) It is recommended that repackaging of wastes be conducted by experienced specialist organizations familiar with the technical requirements necessary to ensure that repackaging and transport are carried out in accordance with relevant guidelines.

165. Waste packages and consignments must be handled in a manner that prevents damage during processing, loading or transportation and must conform to relevant national and international legal requirements.

166. Repackaged pesticide POPs wastes should be fixed with adequate dunnage consisting of wooden structures and/or straps in cargo transport units before transport, in accordance with the recommendations set out in the IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units (IMO/ILO/UNECE, 2014).

167. Adequate precautions should be taken to ensure that containers previously used for carriage of pesticides are not used for other purposes, particularly for storage of food or water for human or animal consumption.

168. Prior to repackaging, certificates for the UN code for each type of container used should be requested from the contractor responsible for safeguarding. In the event that no UN codes are visible on new packaging materials, the materials should be considered as not having been approved by the United Nations.

169. Every container carrying pesticide POPs should be clearly labelled with a hazard warning label and a label giving details of the container and a unique serial number. Such details should include container contents (e.g., exact volume and weight, type of waste carried), pesticide trade name and active ingredients (including concentration), name of original manufacturer, name of the site from which the pesticide 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 under the relevant transport guideline. Contractors and other organizations conducting repackaging activities should ensure that each new container of waste is classified and labelled in accordance with the requirements of the relevant international regulation on the transport of hazardous

materials shown in table 2 **Error! Reference source not found.**, and with the Globally Harmonized System for Classification and Labelling of Chemicals (GHS).

4. Storage

170. Although generally there are few specific regulations or guidelines regarding the storage of pesticide POPs wastes, existing regulations and guidelines on pesticide products should provide a minimum level of protection. In that regard, FAO guidelines on pesticide storage and stock control and on the design and structure of pesticide storage facilities, contained in the Pesticide Storage and Stock Control Manual (FAO, 1996) and the Environmental Management Tool Kit for Obsolete Pesticides, volumes 1-4 (FAO, 2009a, 2009b, 2011a, and 2011b), should be followed as minimum standards. In addition, pesticide POPs wastes should be stored in a similar manner as hazardous waste. Storage should require authorization from local authorities and verification of authorization documents, which could deal with, for example, maximum quantities, permission for repackaging in a temporary storage site, maximum period of temporary storage and permission for substandard temporary storage).

G. Environmentally sound disposal

1. Pre-treatment

171. The selection of a pre-treatment method for a particular pesticide POPs waste should be based on the nature and type of waste to be pre-treated and could include any of the techniques described in subsection IV.G.1 of the General technical guidelines. The most common pre-treatment processes for pesticide wastes, including pesticide POPs wastes, are:

(a) Volume reduction: It is especially important that wastes with low densities and (in the case of containers) large void spaces, such as contaminated pesticide packaging, be reduced in volume. Such pre-treatment operations should not, however, disperse pesticide POPs in the environment or in the atmosphere of the workshop. Contaminated empty steel drums can be crushed, while contaminated empty plastic containers are amenable to cutting or shredding; all operations should be performed in controlled atmosphere as they are likely to emit pesticide POPs.

(b) Low temperature thermal desorption (LTTD): LTTD has been used successfully to pre-treat soils heavily contaminated with pesticides (Troxler et al., 1993; Sahle-Demessie and Richardson, 2010). The LTTD process can be integrated directly into the destruction process, or done separately. When it is integrated, volatilised pesticides are fed directly into the destruction process. In cases where contaminated soil is far away from a destruction facility, the LTTD process can be located close to the site where the soil is located. Volatilised pesticides should be made suitable for transportation to a destruction facility, e.g. by condensing and repackaging.

(c) Solvent washing: This process has been used successfully in the decontamination of empty containers through triple rinsing. Contaminated solvents can be recycled through distillation to generate a concentrate of pesticide contaminants. Recycled solvents should be used in the decontamination of other pesticide POPs wastes and other pesticide wastes.

(d) Blending with activated carbon or other adsorbent: This method has been used to attenuate odour. Other odour control technologies such as wet scrubbing are identified in the European Commission “Best Available Techniques (BAT) Reference Document (BREF) for Common Waste water and Waste Gas Treatment/Management Systems in the Chemical Sector” (European Commission, 2016).²⁸

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

2. Destruction and irreversible transformation methods

173. 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

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

²⁸ Available from: https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/CWW_Bref_2016_published.pdf (chapter 3.5.5 on “Odour emissions” and paragraph 4.5.5 provide BAT to prevent or, where that is not practicable, to reduce odour emissions).

4. Other disposal methods when the POP content is low

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

H. Remediation of contaminated sites

176. Contaminated soil represents a significant challenge in particular to developing countries and countries with economies in transition. Previous widespread over-application may have resulted in a large volume of soil contaminated with POP pesticides. Furthermore, any remaining stocks of POPs pesticides have in many cases leaked as the containers have deteriorated in storage. This has given rise to large volumes of contaminated soil. The concentrations of pesticides in the soil vary from the “hot-spot” at the source of the contamination to lower concentrations where the contamination has dispersed. Given the large volumes of contaminated soil from a single point source leakage, economics play a significant role in determining the method for mitigating the risks of the site (see also Ericson et al., 2020).

177. The General technical guidelines in section IV, H describe the processes for identification and assessment of the risks posed by contaminated sites (see also Cobban et al., 2020a and 2020b). A risk mitigation plan should be developed for each site to reduce as far as feasible the risks posed to public health and the environment. The risk mitigation plan should consider all the possible pathways for the dispersion of the contamination from the site, for example: surface water run-off and penetration to ground water; volatilization and wind transportation of contaminated particles; and physical contact with humans and animals. Where a site is characterized by different zones, each with different contaminants and contamination levels, it is likely to be most feasible to adopt a different risk mitigation strategy for each zone.

178. It should be a priority to treat the relatively low volumes of contaminated soil with a POP content far above the low POP content (“hot-spot”). This could be either conducted by excavating and packaging the contaminated soil so that the waste can be sent for an environmentally sound disposal using the methods identified in section G.2 or G.3 above; or with a pre-treatment step where the POPs are extracted from the soil and only extracted concentrated POP waste is packaged and sent for such disposal.

179. However, outside the hot-spot, there can be large volumes of soil with POP contents above or below the low POP content which represent a lower risk to public health and environment because of their low volatility and leachability (except in the case of PFOS which is classified as a volatile organic compound). In this case it is recommended to consider pre-treating the soil to extract POPs from it so that the extracted concentrated POP waste can be sent for an environmentally sound disposal using the methods identified in section G.2 or G.3 above. In cases where this is not feasible, and the waste characteristics are suitable, the excavated waste may be sent for an environmentally sound disposal using the methods identified in section G.3 above in case the POP content is above the low POP content or G.4 above in case the POP content is below the low POP content. Before such disposal, the soil may be pre-treated to immobilize the POPs for example by mixing with activated carbon to adsorb any free pesticides or by stabilization and solidification. In other cases where there are no risks to ground water contamination, it may be appropriate to leave the soil in situ and implement appropriate risk mitigation plans (see paragraph 176). This could include installing physical barriers to prevent contact with the soil surface and to prevent the spread of the contamination underground.

180. For information, see section IV.H of the General technical guidelines and the FAO Environmental Management Tool Kit for Obsolete Pesticides, volume 5 (on risk assessment of contaminated sites) (Cobban et al., 2020a) and volume 6 (on risk reduction methodologies for contaminated sites) (Cobban et al., 2020b).

I. Health and safety

181. For information, see section IV.I of the General technical guidelines. See also Cobban et al., 2020a and 2020b; Ericson et al., 2020.

1. Higher-risk situations

182. Higher-risk situations specific to pesticides POPs may occur:

- (a) During storage and management of stocks of obsolete pesticides;
- (b) At landfills and burial sites where pesticides have been disposed of;
- (c) When used pesticides containers are reused for other purposes.

183. For further information, see subsection IV.I.1 of the General technical guidelines. See also Cobban et al., 2020a and 2020b; Ericson et al., 2020.

2. Lower-risk situations

184. For information, see subsection IV.I.2 of the General technical guidelines.

J. Emergency response

185. Emergency response plans should be in place for pesticide POPs in storage, in transit and at disposal sites. Further information on emergency response plans is provided in section IV.J of the General technical guidelines.

K. Public participation

186. Parties to the Basel or Stockholm conventions should have open public participation processes. For further information on this issue, see section IV.K of the General technical guidelines.

Annex I to the technical guidelines

Synonyms and trade names for pesticide POPs

(See also EPA, Substance Registry System; Helsinki Commission, 2001; Holoubek et al, 2004; PAN Pesticides Database – Chemicals; Ritter et. al, 1995; EPA, Substance Registry Services; and STARS Version 4.2.) Full references can be found in annex II below (bibliography).

Chemical	Some synonyms and trade names ^a
Aldrin (CAS No: 309-00-2)	<p>1,4:5,8-dimethano-naphtalin;</p> <p>1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-exo-5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-5,8-exo-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a hexahydro (1.alpha., 4.alpha., 4a.beta., 5.alpha., 8.alpha., 8abeta);</p> <p>1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene;</p> <p>1.2.3.4.10.10-hexachlor-(4arh.8ach)-1.4.4a.5.8.8a-hexahydro-1c.4c:5t.8t-dimethanonaphth;</p> <p>1.2.3.4.10.10-hexachloro-(4arh.8ach)-1.4.4a.5.8.8a-hexahydro-1c.4c:5t.8t-dimethano-napht;</p> <p>1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, endo,exo-;</p> <p>(1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-hexachlor-1,4,4a,5,8,8a-hexahydro-1, 4:5,8-dimethanonaphthalin;</p> <p>exo-Hexachlorodimethanonaphthalene;</p> <p>Hexachloro-1,2,3,4,10,10 hexahydro-1,4,4a,5,8,8a exodimethano-1,4,5,8 naphtalene;</p> <p>Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalin;</p> <p>Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethano-naphtalin, (1R,4S,4aS,5S,8R,8aR)-1,2,3,4,10,10-;</p> <p>Hexachlor-1,4,4a,5,8,8a-hexahydro-1,4-endo-5,8-exodimethanonaphthalin, 1,2,3,4,10,10-;</p> <p>Hexachlorhexahydro-dimethano-naphtaline;</p> <p>Hexachlorohexahydro-endo, exo-dimethanonaphthalene</p> <p>Trade names</p> <p>Aglyucon*, Agronex TA; Aldocit; Aldrec; Aldrex; Aldrex 30; Aldrex 30 E.C.; Aldrex 40; Aldrin cast solid; Aldrin mixture, dry (with 65 per cent or less aldrin); Aldrin mixture, dry (with more than 65 per cent aldrin); Aldrin mixture, liquid (with 65 per cent or less aldrin); Aldrin mixture, liquid (with 65 per cent or less aldrin); Aldrin 2.5; Aldrin 5;</p> <p>Aldrite; Aldrosol; Alttox; Alvit 55; Compound 118; 4:5,8-Dimethanonaphthalene; 22DN*; Drinox; Eldrin; ENT-15949; Eruzin*;</p> <p>GGDN*;HHDm; HHDN; HHPN; Kartofin*; Kortofin; Latka 118; NA 2761; NA 2762; NCI-C00044; OMS-194; Octalene; Octalin*;Seedrin; SD 2794; Sojedinienie (= compound) 118*; Tatzinho; Tipula; Veratox*</p>
Alpha HCH (CAS No: 319-84-6)	<p>1,2,3,4,5,6-hexachlorocyclohexane, alpha isomer, (1alpha,2alpha,3beta,4alpha,5beta,6beta)-1,2,3,4,5,6-hexachlorocyclohexane, alpha-1,2,3,4,5,6-Hexachlorocyclohexane;</p> <p>Alpha-Benzenehexachloride</p> <p>;</p> <p>Alpha-BHC;</p> <p>alpha-HCH;alpha-lindane; benzene-transhexachloride; Hexachlorocyclohexane-Alpha;</p> <p>Benzene hexachloride-alpha-isomer;;</p> <p>Cyclohexane. 1,2,3,4,5,6 Hexachloro-alpha;</p> <p>Cyclohexane, alpha-1,2,3,4,5-Hexachloro;</p> <p>ENT 9,232</p>

Chemical	Some synonyms and trade names ^a
Beta HCH (CAS No: 319-85-7)	beta-1,2,3,4,5,6-Hexachlorocyclohexane: beta-Benzenehexachloride;, benzene-cis-hexachloride; beta-HCH; beta-Hexachlorocyclohexane; beta-Hexachlorocyclohexane ; beta-isomer; beta-lindane; Hexachlorocyclohexane-Beta; trans-alpha-benzenehexachloride; beta-benzenehexachloride
Chlordane (CAS No: 57-74-9)	1-exo,2-endo,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene; 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetra-hydro-4,7-methan-; 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; 1,2,4,5,6,7,8,8-octachloro-4,7-methano-3a,4,7,7a-tetrahydroindane oindane; 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-endo-methano-indene; 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene; 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-1H-4,7-methano-indene; 1,2,4,5,6,7,8,8-octachloro-4-7-methano-3.alpha.,4,7,7,.alpha.-tetrahydroindane; 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro- 1-exo,2-endo,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene); 4,7-methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; 4,7-methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-; Octachloro-4,7-methanotetrahydroindane; Octachlorodihydrodicyclopentadiene; Octachlorohexahydromethanoindene; Octachlor-2,3,3a,4,7,7a-hexahydro-4,7-methano-(1H)-inden, 1,2,4,5,6,7,8,8-; Octachlor-3a,4,7,7a-tetrahydro-4,7-endomethanoindan, 1,2,4,5,6,7,8,8-; Trade names AG Chlordane; Aspon; Aspon-Chlordane; Belt; CD 68; chloordaan, zuiver; chlordan, kemisk rent; Chlordan, rein; Chlordane; Chlordane (gamma); chlordane, pur; Chlordane technical; Chlordane [4,7-methanoindan, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-]; Chloriandin; Chlorindan; Chlorkil; Chlorodane; gamma.-Chlordan; Clordan; Clordano, puro; Corodan(e); Chlordane HCS 3260; Chlordasol; Cortilan-Neu; Dichlorochlordene: Dowchlor; Dow-Klor; Ent 9932; Ent 25552-X; HCS 3260; Kilex lindane; Kypchlor; M140; M 410; Latka 1068;4,7-methanoindan; 4,7-methano-1H-indene; NCI-C00099; Niran; Octachlor; Octa-Klor; Oktaterr; Ortho-Klor; SD 5532; Shell SD-5532; Starchlor; Synklor; Tat chlor 4; t-chlordan; Topichlor; Topichlor 20; Toxiclor; Unexan-koeder;Veliscol-1068
Chlordecone (CAS No: 143-50-0)	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-; decachloro-pentacyclo[5,2,1,0 ^{2,6} ,0 ^{3,9} ,05,8]- decan-4-one; decachloro-octahydro-1,3,4-metheno- 2H,5H-cyclobuta [cd]-pentalen-2-one Decachlorooctahydro-kepone-2-one; Decachlorotetrahydro-4,7-methanoindeneone) Trade names GC 1189, Kepone, Merex, chlordecone, curlone

Chemical	Some synonyms and trade names ^a
<p>Dicofol (CAS No: 115-32-2 (dicofol; p,p'-dicofol), 10606-46-9 (o,p'-dicofol))</p>	<p>2,2,2-trichloro-1,1-bis(4-chlorophenyl)ethanol; Benzenemethanol, 4-chloro-α-(4-chlorophenyl)-α-(trichloromethyl)-; 4-chloro-α-(4-chlorophenyl)-α-(trichloromethyl)benzene-methanol 1,1-bis(4'-chlorophenyl)2,2,2-trichloroethanol; 1,1-bis(chlorophenyl)-2,2,2-trichloroethanol; 4-chloro-α-(4-chlorophenyl)-α-(trichloromethyl)-</p> <p>Trade names Acarin; AK-20 HC free; Benzenemethanol; Carbox; Cekudifol; CPCA; Decofol; Dicaron; Dichlorokelthane; Dicomite; Difol; DTMC; ENT 23648; FW293; Hilfol; Hilfol 18.5 EC; Kelthane; Kelthanethanol; Kelthane A; Kelthane (DOT); Kelthane Dust Base; Kelthane 35; Milbol; Mitigan; p,p'-dicofol; NA2761 (DOT); NCI-C00486</p>
<p>Dieldrin (CAS No: 60-57-1)</p>	<p>(1α,2β,2α,3β,6β,6α,7β,7α-2,7:3,6-Dimethano-3,4,5,6,9,9-hexachlor-1a,2,2); (1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachlor-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-di; (1R,4S,4aS,5R,6R,7S,8S,8aR)-1,2,3,4,10,10-Hexachlor-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-di; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro,endo,exo-1,4:5,8-dimethanonaphthalene 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-exo-dimethano-naphthalene 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-endo-5,8-dimethanonaphthalene 1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-, endo,; 2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-,(1aalph; 2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-; 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene; 5,6,7,8,9,9-hexachlor-2t,3t-epoxy-(4ar,8ac)-1,2,3,4,4a,5,8,8a-octahydro-1t,4t;5c8c-d; Hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene; Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-; Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethano-naphthalene, (1R,4S,4aS,5R,6R,7S,8S); Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-; Hexachloro-epoxyoctahydro-dimethanonaphthalene</p> <p>Trade names Aldrin epoxide; Alvit; Alvit 55; Compound 497; D-31; Diel'drin*; Dieldrin; Dieldrin, dry weight; Dieldrin (hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene 85 per cent and related compounds 15 per cent); Dil'drin*; Dieldrina; Dieldrine; Dieldrite; Dieldrex; Dieldrix; Dieldrex B, Dielmoth; D-31; DD; dimethanonaphth[2,3-b]-oxirene; DLD; Dorytox; ENT-16225; ENT 16,225; exo-dieldrin; GEOD*; HEOD; HOED; Illoxol; Insektalox*; Insecticide No. 497; Insectlack; Kombi-Albertan; Lakta 497; Moth Snub D; NCI C00124; Octalox; OMS18; Oxralox; Panoram D-31; Quintox; Red Shield; SD 3417; Sojedinenie (=compound) 497*; Termitox</p>

Chemical	Some synonyms and trade names ^a
Endrin (CAS No: 72-20-8)	<p>1a.alpha.,2.beta.,3.alpha.,6.alpha;</p> <p>(1a.alpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)-2,7;3,6-dimethano-3,4,5,6,9,9-hexachlor-1a;</p> <p>(1Aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7Aalpha)3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-;</p> <p>(1R,4S,4aS,5S,7R,8R,8aR)-1,2,3,4,10,10-hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-dime;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a- octahydro-1,4-endo-,8-endo-dimethano-naphthalen;</p> <p>3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-endodimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo, endo-5,8-dimethanonaphthali;</p> <p>1,2,3,4,10,10-hexachloro-6,7-oxido-1,4-endo-5,8-endo-dimethano-1,4,4a,5,6,7,8-octahydronaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-1r,4s,4as,5s,6,7r,8r,8ar-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-1,4-exo-5,8-dimethanonaph;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-§1,4-endo-5,8-endo-dimethanonaphthali;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo-endo-5,8-dimethanonaphthale;</p>

Chemical	Some synonyms and trade names ^a
	<p>2,7:3,6-dimethanonaphth(2,3-b)oxirene, 3,4,5,6,9,9-hexachoro-1a,2,2a,3,6a,7,7a-octahydro-, (1aalpha,2);</p> <p>3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth(2,3-B)oxirene;</p> <p>3,4,5,6,9,9-hexachloro-1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha-octahydro-2,7:3,6-dim;</p> <p>Compound 269; 1,4:5,8-dimethanonaphthalene;</p> <p>endo,endo-1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen;</p> <p>Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-endodimethanonaphthalene, 1,2,3,4,10,10-;</p> <p>Hexachloro-oxido-dimethano-octahydronaphthalene; hexachloroepoxyoctahydro-endo-endo-dimethanonaphthalene;</p> <p>Hexachlorooctahydro-endo, endo-dimethanonaphthalene; hexachloroxido-endo-endo-dimethanoctahydronaphthalin;</p> <p>Hexachloroxido-endo-endo-dimethanoctahydronaphthalene;</p> <p>hexachloroxidotetracyclododecen;</p> <p>hexachloräpoxyoctahydro-bis(endo-methylen)naphthalin;</p> <p>Hexachloroepoxyoctahydro-endo,endo-dimethanonaphthalene</p> <p>Trade names</p> <p>Endrex; Endrin; Endrin 20; Endrin mixture; endrin,endo-endo-isomers; Endrina; Endrine; ENT-17251; Experimental Insecticide No. 269; Hexachlor;</p> <p>Hexadrin; Isodrin Epoxide; Lakta 269; Mendrin; NCI C00157; Nendrin; OMS 197</p>
<p>Heptachlor (CAS No: 76-44-8)</p>	<p>1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene;</p> <p>1,4,5,6,7,8,8-heptachlorotetrahydro-4,7-methanoindene;</p> <p>1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endo-methanoindene;</p> <p>1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7- methanoindene;</p> <p>1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-1H-4,7-methano-indene;</p> <p>2,4-bis-(thylamino)-6-chlor-1,3,5-triazin; 2-Chlor-4,6-bis(ethylamino)-1-triazin;</p> <p>3,4,5,6,7,8,8-heptachlorodicyclopentadiene; 3-chlorochlordene;</p> <p>4,7-methano-1,4,5,6,7,8,8-heptachlor-3a,4,7,7a-tetrahydro-1H-inden;</p> <p>4,7-methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-;</p> <p>4,7-methanoindene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-;</p> <p>Heptachlorotetrahydro-4,7-methanoindene</p> <p>Trade names</p> <p>Aahepta; Arbinex 30TN; Agronex Hepta; Agronex Hepta T 30; Agroceres; Basaklor; Bis(ethylamino)-chlortriazin; Chlor-bis(ethylamino)-triazin;</p> <p>Chlordiethyltriazindiamin; Drinox; Drinox H-34; E 3314; ENT-15152; Eptacloro;</p> <p>Geptachlor*; Geptazol*; Gesatop; Gold Crest H-60; GPKh; H-34; H-60; Hepta;</p> <p>Heptachlor; Heptachlorane; Heptacloro; Heptagran; Heptagranox; Heptamak;</p> <p>Heptamul; Heptasol; Heptox; Latka 104; NCI-C00180; Soleptax; Rhodiachlor;</p> <p>Termide; Tetrahydro; Veliscol 104; Veliscol heptachlor</p>
<p>Hexachlorobenzene (CAS No: 118-74-1)</p>	<p>Agronal H; Amaticin; Amatin; AntiCarie; Benzene, hexachloro-; benzol, Hexachlor;</p> <p>Bunt-cure; Bunt-no-more; Chlorbenzol, hexa; Co-op Hexa; Ceku C.B.; ENT-1719;</p> <p>esaclorobenzene; Gammahexane, GChB*; Gexachlorbenzol*; Granox; Granox nm;</p> <p>HCB; HCBz; hexachloorbenzeen; Hexachlorobenzen; Hexachloro-; Hexa CB; Hexa c.b.;</p> <p>Hexachlorbenzol; Julian's carbon chloride; julin's carbonchloride; julin's chloride;</p> <p>No Bunt; No Bunt 40; No Bunt 80; No Bunt Liquid; Pentachlorophenyl chloride;</p> <p>Perchlorobenzene; Perchlorbenzol; Phenyl perchloryl; Sanocid; Sanocide; Smut-Go;</p> <p>Snieciox; Snieciox 40; Zaprawa nasienna snieciox;</p>
<p>Hexachlorobutadiene (CAS No: 87-68-3)</p>	<p>Perchlorobutadiene; 1,1,2,3,4,4-hexachloro-1,3-butadiene; 1,3-hexachlorobutadiene</p> <p>C-46, Dolen-Pur; UN2279, GP-40-66:120</p>

Chemical	Some synonyms and trade names ^a
<p>Lindane (CAS No: 58-89-9)</p>	<p>Trade names gamma benzene hexachloride; gamma-BHCAgrocide, Aparasin, Arbitex, BBH, Ben-hex, Bentox, Celanex, Chloresene, Dvoran, Dol, Entomoxan, Exagamma, Forlin, Gallogama, Gamaphex, Gammalin, Gammex, Gammexane, Hexa, Hexachloran, Hexaverm, Hexicide, Isotos, Kwell, Lendine, Lentox, Linafor, Lindafor, Lindagam, Lindatox, Lintox, Lorexane, Nexit, Noco-chloran, Novigam, Omnitox, Quellada, Silvanol, Tri-6, Vitron.</p>
<p>Mirex (CAS No: 2385-85-5)</p>	<p>1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachloro-octahydro-1,3,4-metheno-1H-cyclobuta[cd]pentalene; 1,2,3,4,5,5-hexachloro-; 2,3,4,5,5-hexachloro-1,3-cyclopentadiene dimer; 1,3,4-metheno-1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachlorooctahydro-1H-cyclobuta<cd>pentalene; 1,3,4-metheno-1H-cyclobuta(cd)pentalene, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-dodecachlorooctahydro-; 1,3,4-metheno-1H-cyclobuta<cd>pentalene, dodecachlorooctahydro-; 1,3-cyclopentadiene; 1,3-cyclopentadiene, 1,2,3,4,5,5-hexachloro-, dimer; Bichlorendo, CG-1283, Dechlorane, Dechlorane 4070, Dechlorane Plus, Dimer; 1,2,3,4,5,5-dodecachloropentacyclodecane; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decane; Dodecachloro-decahydro-1,3-cyclo-dicyclobuta<cd,gh>pentalene; Dodecachlorooctahydro-1,3,4-metheno-1H-cyclobuta(cd)pentalen, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-; Dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta<cd>pentalene; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decane; Dodecachloropentacyclo<5.2.1.0 per cent 2,6.0 per cent 3,9.0 per cent 5,8>decane; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decane; Perchloropentacyclo(5.2.1.02,6.03,9.05,8)decane</p> <p>Trade names ENT-25719; Ferriamicide; GC1283; Hexachloropentadiene Dimer, Hexachloro-1,3-cyclopentadiene dimer; Hrs 1276, NCI-C06428; Paramex; Perchlordecone, Perchloropentacyclodecane; Perchlorodihomocubane</p>

Chemical	Some synonyms and trade names ^a
<p>Pentachlorophenol and its salts (CAS No: 87-86-5) (CAS No: 131-52-2)</p>	<p>1-Hydroxy-2,3,4,5,6-pentachlorobenzene; 1-Hydroxypentachlorobenzene 2,3,4,5,6-pentachlorophenol; Pentachlorophenol, PCP, sodium pentachlorophenate, Na-PCP; Chlorophen; PCP; penchlorol; penta; pentachlorofenol; pentachlorofenolo; pentachlorophenate; pentachlorphenol; pentanol</p> <p>Trade names</p> <p>Acutox; Albapin; Anti-Pa IV Husbock (SE); Arbezol; Block Penta (USA); BP Hylosan (SE); Chem-Penta; Chem-Pentas; Chem-Tol; Chlon; Chlorophen (USA); Chlorophenasic acid; Chlorophenate; Cryptogil Na; Cryptogil Oil; Cryptogil OL; Dirottox; Dow Dormant Fungicide (Na-PCP); Dow Pentachlorophenol DP-2 Antimicrobial; Dowcide 7/EC-7/G (USA); Dowicide 6 (USA); Dowicide 7 (USA); Dowicide 7 Antimicrobial (USA); Dowicide G (Na-PCP) /G-St (USA); SE Dura Treat II; Dura Treat 40 (USA); Durotox; EP 30; Forpen-50 Wood Preservative; Fingifen; Fongol; Fungifen; G-St (polymeric form); Gantix HB Ijus (SE); Glazd Penta; Grundier Arbezol; Gullviks Husbockscupral (SE); Husbocks-Cuprinol (SE); 1-hydroxypentachlorobenzene; Jimo-Cupim (BR); KMG Technical Penta Flakes (CAN, USA); KMG Technical Penta Blocks (USA); CAN KMG Penta OL Blocks (CAN, USA); KP Cuprinol (SE); Ky-5 (tetrachlorophenol) (FI, SE); Lautor A; Lauxtol; Lauxtol A; Liroprem; Mystox D (polymeric form); Moosuran; Napclor-G (polymeric form); NCI-C 54933; NCI-C 55378; NSC 263497; OnTrack We Herbicide; Ortho Triox Liquid Vegetation Killer; Osmose Wood Preserving Compound; Panta-Kil; BR PCP (USA); Penchlorol (USA); Penta (USA); Penta-ate; BR Penta C 30; Penta Concentrate; Penta Plus 40; Penta Pres 1 10; Penta Ready; Penta solignum (SE); Penta WR; Penta WR1-5; Penwar; Pentachlorofenol (SE); Pentachlorofenolo; Pentachlorophenate; Pentachlorophenate sodium; Pentachlorophenol DP-2; Pentachloropheno; Pentachlorphenol; Pentachlorophenol sodium salt; Pentachlorophenoxy sodium; Pentaclorofenol; BR Pentacon; Penta-kill; Pentanol; Pentaphenate; Pentasol; Pentchloral; Penton 70; Pentor 70; Penwar; Peratox; Perchlorophenol; Permacide; Permagad; Permagard; Permasan; Permatox; Permatox DP-2; Permatox Penta; Permite; Persasan; Phenol pentachloro-sodium derivative monohydrate; Phenol, 2,3,4,5,6-pentachloro-; Phenol, pentachloro-; PKhF; Pol Nu; Pole toppe; Pole toppe fluid; Prevenol; Preventol P; Prilttox; Santobrite (Na-PCP polymeric form); Santophen; Santophen 20 (USA); Sapco-25 Weedbeads (Na-PCP polymeric form); Satophen; Sautox; Sinituho (FI); Sodium PCP; Sodium pentachlorophenate; Sodium pentachlorophenolate; Sodium pentachlorophenoxide; Sontox (USA); Term-i-Trol; Thompson's Wood Fix; Watershed Wood Preservative; Weed-beads; Weed and Brush Killer; Weedone; Withophen P (DE); Withophen N (DE); Witophen N; Witophen P; Woodtreat; Woodtreat A ; Xyladecor (DE); Xylamon (DE); Xylophene Na</p>

Chemical	Some synonyms and trade names ^a
<p>Perfluorooctane sulfonic acid (PFOS), its salts, and perfluorooctane sulfonyl fluoride (e.g. CAS No: 29457-72-5, CAS No: 2991-51-7, CAS No: 1652-63-7)</p>	<p>1-Octanesulfonic acid, 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluoro; 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluoro-1-octanesulfonic acid; 1-Octanesulfonic acid, heptadecafluoro-; 1-Perfluorooctanesulfonic acid; Heptadecafluoro-1-octanesulfonic acid; N-Ethyl Perfluorooctanesulfonamide; Perfluoro-noctanesulfonic acid; Perfluorooctanesulfonic acid; Perfluorooctylsulfonic acid</p> <p>Chemsico Insect Bait A, Chemsico Insect Bait Rep, Chemsico Insect Bait Ss, Chemsico Roach Control System Cs, Finitron, Brand Sulfluramid Ab Mup, Finitron Brand Sulfluramid Lca Mup, Finitron Brand Sulfluramid Termite Mup, Finitron Brand, Sulfluramid Rb Mup, Firstline Gt Plus Termite Bait Station, Firstline Termite Bait Container Station, Firstline Termite Bait Station, Firstline Termite Bait Tube Station, Fluorguard Ant Control Baits, GX-071, Gx-071 Technical, Indoor Roach Bait, Micro-Gen Ant Reactor, MixHortal, Pro-Control Roach Bait, Raid Double Control Ant Baits, Raid Max Ant Bait, Raid Max Roach Bait, Sulfluramid, Volcano Ant Bait</p> <p>Lithium perfluorooctane sulfonate, LPOS, Sulfotine (26% LPOS), RAID TVK (26% LPOS)</p>
<p>Technical endosulfan (CAS No: 115-29-7) and its related isomers (CAS No: 959-98-8 and CAS No: 33213-65-9)</p>	<p>alpha...beta.-1,2,3,4,7,7-Hexachlorobicyclo(2.2.1)-2-heptene-5,6-bisoxymethylene sulfite; .alpha...beta.-1,2,3,4,7,7-Hexachlorobicyclo(2.2.1)hepten-2-bis(oxymethylon-5,6-)sulfite; .beta.-6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-endo-6,9-methano-2,4,3-benzodioxathiepin 3-oxide; 1,4,5,6,7,7-Hexachloro-5-norbornene-2,3-dimethanol, cyclic sulfite; 5-Norbornene-2,3-dimethanol, 1,4,5,6,7,7-hexachloro-, cyclic sulfite; 6,7,8,9,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide; 6,9-Methano-2,4,3-benzodioxathiepin; 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide; Hexachlorohexahydromethano-2,4,3-benzodioxathiepin-3-oxide</p> <p>Trade names Afidan, Benzoepin, Beosit, BIO 5462, Chlorthiepin, Crisulfan, cyclic ester with 1, Cyclodan, Cyclodan, Devisulfan, Endocel, Endocide, Endosol, Endosulf^o, Endosulfam, Endosulfan, Endosulfan (MIXED ISOMERS), Endosulfan (mixture of alpha and beta isomers), Endosulfan 35EC, Endosulphan, Endosulfan, ENT-23979, FMC 5462, FMC 5462, , Hexasulfan, Hildan, HOE 2671, Insectophene, Kop-Thiodan, Malix, Phaser, Thionex. Sulfurous acid, cyclic ester with 1,4,5,6,7,7-hexachloro-5-norbornene-2,3-dimethanol, Thifor, Thimul, Thiodan.</p>
<p>Toxaphene (CAS No: 8001-35-2)</p>	<p>2,2-dimethyl-3-methylene norbornane chloride; chloriertes 2,2-Dimethyl-3-methylenbornan; Dimethyl-3-methylenbornanchlorid, 2,2-</p> <p>Trade names Agricide; Maggot Killer (f); Alltex; Alltox; Attac; Attac 4-2; Attac 4-4; Attac 6; Attac 6-3; Attac 8; Camphechlor; Camphechlor, polychloriert; Camphechlore; Camphene, chlorinated; Camfechlor*; Camphochlor; Campheclor; Chem-Phene; Chemphene M5055; Camphofene Huileux; Chlorinated Camphene; Chloriertes Camphen; Chlorinated camphene, chlorinated camphene, 67 per cent <conc chlorine<69per cent ; technical; Chloro-Camphene; Clor Chem T-590; Compound 3956; Coopertox; Crestoxo; Cristoxo; Cristoxo 90; Delicia Fribal; Estonox; ENT-9735; Fasco-Terpene; Geniphene; Gy-Phene; Hercules 3956; Hercules toxaphene; Huilex; Kamfochlor; Liro Toxaphen 10; M 5055; maggot killer (f); Melipax; Melipax 60 EC; Melipax do zamglawiania; Melipax plynny; Melipax pylisty; Melipex; Motox; NCI-C00259; Octachlorocamphene; PCC; Penhene; Phenacide; Phenatox; Phenphane; Polichlorcamfen*; Polychlorocamphene; polychloriertes Camphechlor; (Poly)chlorinated camphene; Strobane-T; Strobane T-90; Taxaphene; Terpentol plynny 60; Toxadust; Toxafen*; Toxakil; Toxaphene (Campechlor); Toxaphene (polychlorinated camphenes); Toxaphene (technical chlorinated camphene (67–69per cent chlorine); Toxon 63; Toxaphen 10; Toxaphen 50; Toxyphene; Vertac Agricide; Vertac 90 per cent</p>

^a The list of trade names is not intended to be exhaustive.

* Russian trade names.

Annex II to the technical guidelines

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