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**Conference of the Parties to the Basel Convention
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Hazardous Wastes and Their Disposal
Twelfth meeting**
Geneva, 4–15 May 2015
Agenda item 4 (b) (i)

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

Technical guidelines

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

Note by the Secretariat

At its twelfth meeting, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal adopted, in decision BC-12/3 on technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants, the technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with the pesticides aldrin, alpha hexachlorocyclohexane, beta hexachlorocyclohexane, chlordane, chlordecone, dieldrin, endrin, heptachlor, hexachlorobenzene, lindane, mirex, pentachlorobenzene, perfluorooctane sulfonic acid, technical endosulfan and its related isomers or toxaphene or with hexachlorobenzene as an industrial chemical, on the basis of the draft technical guidelines contained in document UNEP/CHW.12/INF/15. The technical guidelines referred to above were prepared by the Food and Agriculture Organization of the United Nations as lead organization for this work taking into account comments received from members of the small intersessional working group on persistent organic pollutants wastes by 27 March 2015. The text of the final version of the technical guidelines, as adopted, is set out in the annex to the present note.

Annex

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

Revised final version (15 May 2015)

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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
EPA	Environmental Protection Agency (United States of America)
ESM	environmentally sound management
FAO	Food and Agriculture Organization of the United Nations
GHS	Globally Harmonized System for Classification and Labelling of Chemicals
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-p-dioxin
PCDF	polychlorinated dibenzofuran
Pesticide POPs	group of pesticides listed in Annex A to the Stockholm Convention (i.e., aldrin, chlordane, chlordecone, dieldrin, endosulfan, endrin, alpha-HCH, beta-HCH, heptachlor, hexachlorobenzene (HCB), lindane, mirex and toxaphene) and HCB as an industrial chemical
POP	persistent organic pollutant
ULV	ultra low volume
UNECE	United Nations Economic Commission for Europe
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 for the environmentally sound management (ESM) of wastes consisting of, containing or contaminated with the pesticides aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex or toxaphene or with HCB as an industrial chemical of March 2007.
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, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), lindane, mirex, pentachlorobenzene, perfluorooctane sulfonic acid (PFOS), 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 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 in 2009 and the amendments entered into force in 2010. 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.
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 pentachlorobenzene 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, 2015). 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 (PFOF) (PFOS technical guidelines) (UNEP, 2015a).
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, 2015b). The general technical guidelines are intended to serve as an "umbrella" guide for the ESM of wastes consisting of, containing or contaminated with POPs and provide more detailed information on the nature and incidence of wastes consisting of, containing or contaminated with pesticide POPs for purposes of their identification and management.

¹ Decisions IV/17, V/26, VI/23, VII/13, VIII/16, BC-10/9, BC-11/3 and BC-12/3 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 and OEWG-9/3 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 and SC-5/3 of the Conference of the Parties of the Stockholm Convention.

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 use 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 at May 2015.

9. As a general rule, the originally listed pesticide POPs (i.e., those that were listed in Annex A to the Stockholm Convention at the time of its entry into force in 2004) did not include specific exemptions for production. Specific exemptions were included for some uses of those pesticides but have now expired and are no longer available to Parties. Those exemptions are therefore labelled in table 1 as “no longer available”. Information on the current use of pesticide POPs can be found in the registers of acceptable purposes and specific exemptions of the Stockholm Convention on the Convention website (www.pops.int).² 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/>).

10. Under Article 5 of the Stockholm Convention, Parties are required to reduce total releases from anthropogenic sources of each of the chemicals listed in Annex C (“Unintentional production”), i.e., unintentionally produced HCB, PeCB, PCB, PCDF and PCDD, with the goal of their continuing minimization and, where feasible, ultimate elimination.

Table 1: Status of pesticide POPs listed under the Stockholm Convention and of specific exemptions/acceptable purposes

Listed pesticide POPs ³	Date of entry into force of the listing ⁴	Annex(es)	Specific exemptions / Acceptable purposes available as of May 2015	
			Production	Use
<u>Aldrin</u>	17 May 2004	A	None	No longer available
<u>Alpha hexachlorocyclohexane</u>	26 August 2010	A	None	None
<u>Beta hexachlorocyclohexane</u>	26 August 2010	A	None	None
<u>Chlordane</u>	17 May 2004	A	No longer available	No longer available
<u>Chlordecone</u>	26 August 2010	A	None	None
<u>Dieldrin</u>	17 May 2004	A	None	No longer available
<u>Endrin</u>	17 May 2004	A	None	None
<u>Heptachlor</u>	17 May 2004	A	None	No longer available
<u>Hexachlorobenzene (HCB)</u>	17 May 2004	A and C	No longer available	No longer available
<u>Lindane</u>	26 August 2010	A	None	Human health pharmaceutical for control of head lice and scabies as second line treatment
<u>Mirex</u>	17 May 2004	A	No longer	No longer available

² <http://chm.pops.int/Implementation/Exemptions/RegisterofSpecificExemptions/tabid/1133/Default.aspx>.

³ As at March 2015.

⁴ One year after the date the adoption of the amendment is communicated to the Parties by the depositary of the Stockholm Convention. For details, see Articles 21 (“Amendments to the Convention”), para. (4), 22 (“Adoption and amendment of annexes”), paras. (3) (c) and (4), and 25 (“Ratification, acceptance, approval or accession”), para. (4), of the Stockholm Convention.

Listed pesticide POPs ³	Date of entry into force of the listing ⁴	Annex(es)	Specific exemptions / Acceptable purposes available as of May 2015	
			Production	Use
			available	
Pentachlorobenzene	26 August 2010	A and C	None	None
<u>Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride</u>	26 August 2010	B	For the uses listed As allowed for Parties listed in the Register	Acceptable purpose: Insect baits for control of leaf-cutting ants from <i>Atta spp.</i> and <i>Acromyrmex spp.</i> Specific exemption: Insecticides for control of red imported fire ants and termites ⁵
<u>Technical endosulfan and its related isomers</u>	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

11. The originally listed pesticide POPs (see paragraph 9 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, organophosphorous 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.

12. 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.

13. 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) Obsolete pesticides (in solid and liquid form) in original packages: These can be large or small stockpiles of obsolete pesticides 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.

(b) 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.

(c) Contaminated soil: 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

⁵ Pesticide uses only are listed in this table – additional use exemptions for industrial and consumer products are not included.

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 soil can also be found in areas where pesticides have been spilt 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. outdoor public spaces, transportation corridors, and utility infrastructure).

(d) Contaminated empty packaging: following the use of pesticide POPs, their original packaging could contain residual contamination. These containers were 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.

(e) 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.

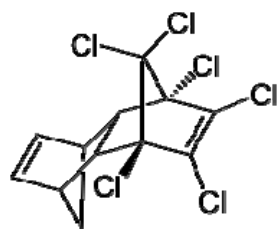
(f) Production wastes: Some pesticide POPs wastes can occur as residues from pesticide production processes. For example, the production process for lindane generates a mixture of POP isomers (alpha- and beta-HCH). At some lindane manufacturing facilities large stockpiles of these production wastes have 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.

14. Subsections 1-13 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: Structure of aldrin



15. Aldrin (CAS No. 309-00-2) is a white, odourless crystal when it is pure. The structure of aldrin is shown in Figure 1 above. Technical grades are tan to dark brown and have a mild chemical odour (Ritter et al., 1995). Aldrin is almost insoluble in 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.⁶

(b) Production

16. Aldrin was produced in the United States 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 in 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

17. 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 peaked at 8,550 tonnes and by 1970 had decreased to 4,720 tonnes (ATSDR, 2002; UNEP, 2003d). There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

18. 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.

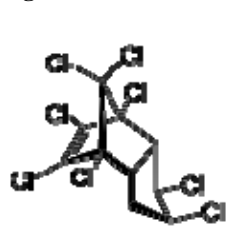
(d) Waste

19. Parties, in accordance with their Stockholm Convention national implementation plans, have reported few stockpiles of aldrin. Waste aldrin, in the form of obsolete pesticide, can be found in:

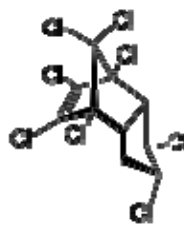
- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Buried pesticides;
- (e) Contaminated soil; and
- (f) Contaminated building materials.

2. Chlordane

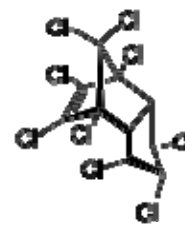
Figure 2: Structures of chlordane isomers



cis-chlordane (also known as α -chlordane)



trans-chlordane (also known as γ -chlordane)



trans-nonachlor

⁶ Handbook of Environmental fates and Exposure Data: For Organic Chemicals Howard, CRC Press, p. 12. (1991).

(a) Description

20. Technical chlordane (CAS no. 57-74-9) is a viscous mixture of at least 23 different compounds, including chlordane isomers, other chlorinated hydrocarbons and by-products. 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). The structures of chlordane isomers are shown in Figure 2 above. 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 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 IRIS database).

(b) Production

21. 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 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

22. 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).

23. 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). There are no specific exemptions for use of chlordane under the Stockholm Convention (previous exemptions have expired).

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

(d) Waste

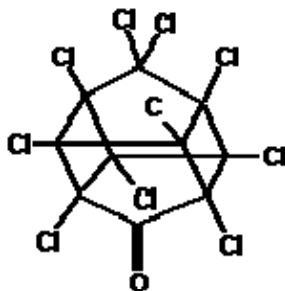
25. Waste chlordane and waste chlordane formulations can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil; and
- (e) Buried pesticides.

3. Chlordecone

(a) Description

Figure 3: Structure of chlordecone



26. 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 structure of chlordecone is shown in Figure 3 above. 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.⁷ 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, 2004a). Chlordecone has a high potential for bioaccumulation in fish and other aquatic organisms (ATSDR, 1995).

(b) Production

27. Chlordecone was produced and exported by Allied Chemicals in the United States, where production ceased in 1977. Between 1951 and 1975, approximately 1.6 million kg of chlordecone were produced in the United States (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 1985; EPA, 1978b quoted in UNEP, 2006) [(Modified from US ATSDR, 1995)] In the United States, its registration was cancelled by 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

28. 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, 2004a; ATSDR, 1995). Chlordecone continued to be used in several countries after it was banned in the United States in 1978. There are no specific exemptions for use of the chemical under the Stockholm Convention.

29. 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

⁷ Integrated Risk Information System (IRIS), EPA.

contained the following percentages of active ingredient: 0.125 per cent (used in the United States in ant and roach traps), 5 per cent (exported for banana and potato dusting), 25 per cent (used in the United States 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).

(d) Waste

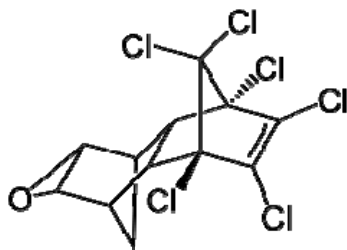
30. Waste chlordecone and waste chlordecone formulations can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags, bottles; and
- (d) Buried pesticides.

4. Dieldrin

(a) Description

Figure 4: Structure of dieldrin



31. 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 structure of dieldrin is shown in Figure 4 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, 1975).

(b) Production

32. Dieldrin was developed by J. Hyman & Co. and licenced to Shell International Chemical Co. and Velsicol Chemical Company in the United States. It was exported throughout the world. The 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

33. 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).

34. 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

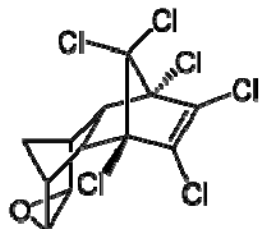
35. Waste dieldrin can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil; and
- (e) Buried pesticides.

5. Endrin

(a) Description

Figure 5: Structure of endrin



36. Endrin (CAS no. 72-20-8), when pure, is a white crystalline solid with a melting point of 200°C. The structure of endrin is shown in Figure 5 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 date; WHO-FAO, 1975).

(b) Production

37. Endrin was developed by J. Hyman & Co. and was licenced to Shell International Chemical Co. and by Velsicol Chemical Company in the United States 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

38. 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. 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 (Blus et al., 1989). There are no specific exemptions for use of the chemical under the Stockholm Convention.

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

(d) Waste

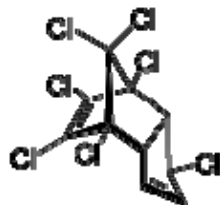
40. Waste endrin can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil; and
- (e) Buried pesticides.

6. Heptachlor

(a) Description

Figure 6: Structure of heptachlor



41. Pure heptachlor (CAS No. 76-44-8) is a white crystalline solid with a melting point of 95°C–96°C. The structure of heptachlor is shown in Figure 6 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, 1993; IPCS INCHEM, no year; WHO-FAO, 1975). 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

42. The original patent holder and maker of heptachlor was chemical company BASF-GmbH AG. In the United States, 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

43. 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, 1993; 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).

44. 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, 1977a; Izmerov, 1982; Worthing & Walker, 1987; FAO/WHO, 1989; Tomlin, 1999).

(d) Waste

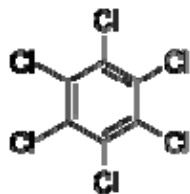
45. Waste heptachlor and waste heptachlor formulations can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil; and
- (e) Buried pesticides.

7. Hexachlorobenzene (HCB)

(a) Description

Figure 7: Structure of hexachlorobenzene



46. Hexachlorobenzene (HCB) (CAS No. 118-74-1) is a chlorinated monocyclic aromatic compound in which the benzene ring is fully substituted by chlorine. The structure of HCB is shown in Figure 7 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

47. 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. 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

48. 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. There are no specific exemptions for use of the chemical under the Stockholm Convention (previous exemptions have expired).

49. 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.

50. 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. 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

51. Waste HCB pesticides can be found in:

(a) Original packaging of obsolete pesticides, in small amounts;

- (b) Large stockpiles of HCB production waste from polyvinyl chloride manufacturing facilities, either as packages or as underground burials;
- (c) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks; and
- (d) Contaminated packaging materials such as drums, bags and bottles.

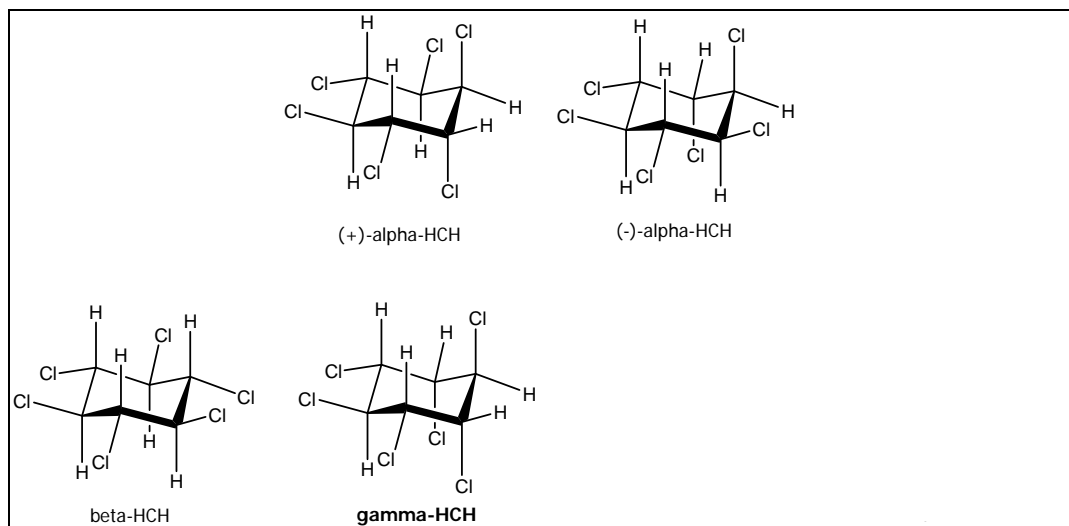
52. Waste HCB as an industrial chemical can be found in:

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

8. Hexachlorocyclohexane (including alpha- and beta-HCH and lindane)

(a) Description

Figure 8: Structure of hexachlorocyclohexane POPs isomers



53. Lindane (CAS No. 58-89-9), also known as gamma-hexachlorocyclohexane (γ -HCH), gammaxene and Gammallin and erroneously known as benzene hexachloride (BHC), is an organochlorine chemical variant of hexachlorocyclohexane (HCH). Lindane is the gamma isomer of HCH. Lindane is a white poisonous crystalline powder with a slight musty odour; its IUPAC name is 1,2,3,4,5,6-hexachlorocyclohexane.⁸

54. Other isomers of HCH, namely alpha-HCH (CAS No 319-84-6) and beta-HCH (CAS No 319-85-7), are notably more toxic than lindane, lack its insecticidal properties, and are by-products of lindane production. The structures of lindane, alpha-HCH and beta-HCH are shown in Figure 8 above. Alpha- and beta-HCH are stereoisomers of gamma-HCH, the active ingredient of lindane. They 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).

⁸ 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.

(b) Production

55. 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

56. 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. 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. For its related isomers alpha-HCH and beta-HCH, there are no specific exemptions for use.

57. 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 (Hauzenberg, I. et al., 1990).

58. The alpha-HCH and beta-HCH isomers were never used and only occurred as by-products in the manufacture of lindane.

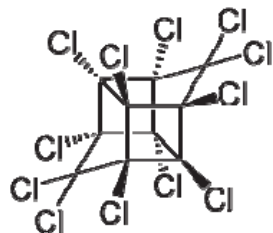
(d) Waste

59. Waste lindane and waste lindane formulations can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil;
- (e) Buried pesticides; and
- (f) Stockpiles of production wastes. The production of lindane created large amounts of waste containing other isomers of hexachlorocyclohexane including the alpha and beta isomers. The total quantity of waste was about 8 times the lindane output.

9. Mirex**(a) Description**

Figure 9: Structure of mirex



60. 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 structure of mirex is shown in Figure 9 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.⁹ 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, 2000b).

(b) Production

61. Production of mirex began in the United States 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

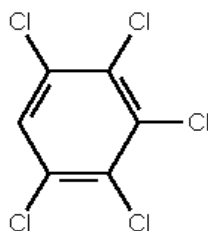
62. Mirex was most commonly used in the 1960s as an insecticide to control imported fire ants in nine southern states of the United States. Mirex was chosen in fire ant eradication programmes because of its effectiveness and selectiveness. It was originally applied aerially at concentrations of 0.3–0.5 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. All registered products containing mirex were effectively cancelled in the United States 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. Many other countries subsequently banned the chemical. There are no specific exemptions for use of the chemical (previous exemptions have expired) for mirex under the Stockholm Convention.

(d) Waste

63. Waste mirex can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles;
- (d) Contaminated soil; and
- (e) Buried pesticides.

⁹ Kaiser KLE, Pesticide Report: The rise and fall of Mirex. Environ. Sci. Technol. 1978, 12(5), 520-528.

10. Pentachlorobenzene (PeCB)**(a) Description****Figure 10:** Structure of pentachlorobenzene

64. Pentachlorobenzene (PeCB) (CAS No. 608-93-5) belongs to the group of chlorobenzenes. The structure of PeCB is shown in Figure 10 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, 2015).

(b) Production

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

66. 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 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.

67. 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 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.

(c) Use

68. PeCB is present as an impurity in commercial pesticides which are still used in Europe, Canada and the United States, 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.

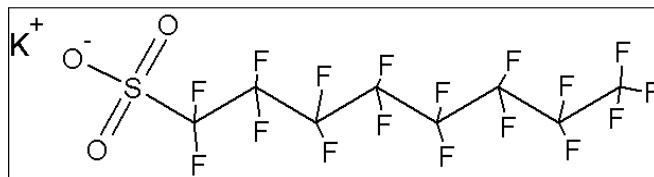
(d) Waste

69. PeCB wastes are rarely found in stockpiles of obsolete pesticides.

11. Perfluorooctane sulfonic acid (PFOS)

(a) Description

Figure 11: Structure of PFOS



70. Perfluorooctane Sulfonic Acid (PFOS) is a member of a larger family of perfluoroalkyl substances (PFAS) (UNIDO, 2009), which are covered by the PFOS technical guidelines (UNEP, 2015a). In addition to its industrial uses, N-Ethyl perfluorooctane sulfonamide (EtFOSA; sulfluramid; CAS No. 4151-50-2, hereinafter referred to as “sulfaramid”) is used as a surfactant and as a pesticide. These two uses are covered in the present guidelines. The structure of PFOS is shown in Figure 11 above.

71. In addition to their function as pesticides, fluorosurfactants may be used as adjuvants in pesticide formulations. 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.¹⁰ PFOS derivatives were used in pesticides because they were considered to be reasonably inert and non-toxic to humans (UNIDO, 2012).

(b) Production

72. PFOS, its salts and PFOF are still being produced for acceptable purposes and exemptions that have been claimed under the Stockholm Convention for specific uses such as insect baits for control of leaf-cutting ants.

73. The production of sulfluramid is often carried out in a closed system, with no releases (discharges, losses or emissions). The best available process results in a product with purity of at least 98 per cent. Sulfluramid was introduced in Brazil in 1993, after verification of its efficiency with many leaf-cutting ant species, replacing the active ingredient dodecachlor (Zanuncio et al, 1993).

(c) Use

74. Sulfluramid is the active ingredient in the manufacturing of ant baits for the control of leaf-cutting ants in ready-to-use formulations (3 g/kg). Sulfluramid is a PFOS precursor that was used in insecticides at a concentration of 0.01 -0.1 per cent at an annual volume of up to 17 tonnes (OECD, 2006).

75. The amendment listing PFOS in Annex B to the Stockholm Convention, which entered into force on 26 August 2010, included specific exemptions for certain uses. In 2015, sulfluramid was still registered in China for use as a pest control agent to control cockroaches, white ants and fire ants. In 2010, sulfluramid was registered in Brazil as an active ingredient for the production of bait to control leaf-cutting ants, as were fipronil and chlorpyrifos, which are considered to be more acutely toxic to humans and the environment than sulfluramid.

(d) Waste

76. Wastes consisting of, containing or contaminated with PFOS and its related substances resulting from its use as a pesticide, can be found in:

- (a) Stockpiles of obsolete pesticides;

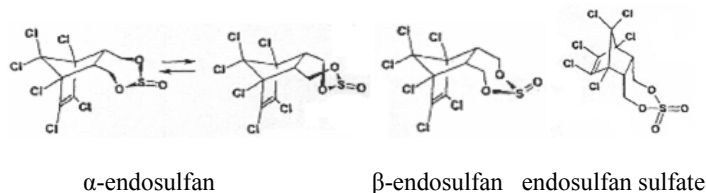
¹⁰ UNEP/POPS/POPRC.6/13/Add.3.

- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags and bottles; and
- (d) Contaminated soil.

12. Technical endosulfan and its related isomers

(a) Description

Figure 12: Structure of endosulfan isomers



77. Technical endosulfan (CAS 115-29-7) is a chlorinated cyclodiene pesticide. Endosulfan is a derivative of hexachlorocyclopentadiene and is chemically similar to aldrin, chlordane and heptachlor. The two isomers, endo and exo, are known popularly as I and II. Endosulfan sulfate is a product of oxidation containing one extra O atom attached to the S atom. Technical endosulfan is a 7:3 mixture of stereoisomers, designated α and β . α - and β -Endosulfan are conformational isomers arising from the pyramidal stereochemistry of sulfur. The structures of endosulfan isomers and endosulfan sulfate are shown in Figure 12 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.

(b) Production

78. 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 (RIVM, 2011). The amendment whereby the Parties listed technical endosulfan and its related isomers in Annex A to the Stockholm Convention (“Elimination”), which entered into force on 27 October 2012, included a specific exemption for production. All registrations of specific exemptions expire five years after the date of entry into force of the Convention with respect to the chemical, i.e., 27 October 2017, unless the Conference of the Parties decides to extend the expiry date (See Article 4 of the Stockholm Convention). China has registered an exemption to continue to produce endosulfan.

(c) Use

79. 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.¹¹ The amendment through which technical endosulfan and its related isomers were listed in Annex A to the Stockholm Convention included a specific exemption for use that is set to expire five years after the date of entry into force of the Convention with respect to the chemical, i.e., on 27 October 2017 (See Article 4, paragraph (b), of the Stockholm Convention). These uses include e.g. cotton bollworm, tobacco and onion aphids eradication and many other borer type insects including leaf rollers in several countries including China, Costa Rica and Zambia.

¹¹ See BiPRO GmbH, Germany, “Risk Management Evaluation Endosulfan – Long Version. UNECE Context” (May 2010).

80. 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 wetttable 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

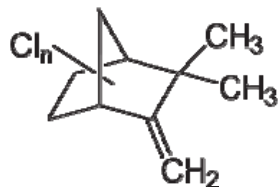
81. Waste endosulfan and waste endosulfan formulations can be found in:

- (a) Stockpiles of obsolete pesticides;
- (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
- (c) Contaminated packaging materials such as drums, bags, bottles;
- (d) Buried pesticides; and
- (e) Contaminated soils.

13. Toxaphene

(a) Description

Figure 13: Structure of toxaphene



82. Toxaphene (CAS No. 8001-35-2) is an insecticide containing over 670 polychlorinated bicyclic terpenes consisting predominantly of chlorinated camphenes. The structure of toxaphene is shown in Figure 13 above. Toxaphene formulations included wetttable powders, emulsifiable concentrates, dusts, granules, baits, oils and emulsions (IARC, 1979; ATSDR, 1996). 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, 1996; Fiedler et al., 2000; IPCS INCHEM, no date; EPA, 2000b).

(b) Production

83. Toxaphene was first produced commercially in 1947 in the United States by Hercules Powder Company. It was once the most heavily manufactured pesticide in the United States, with a maximum production volume of 23,000 tonnes in 1973 (ATSDR, 1996; 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

84. Toxaphene was one of the most heavily used insecticides in the United States 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, 1996; Fiedler et al., 2000). There are no specific use exemptions for toxaphene under the Stockholm Convention.

(d) Waste

85. Waste toxaphene and waste toxaphene formulations can be found in:
- (a) Stockpiles of obsolete pesticides;
 - (b) Contaminated equipment such as shelves, spray pumps, hoses, personal protective materials and storage tanks;
 - (c) Contaminated packaging materials such as drums, bags and bottles;
 - (d) Contaminated soil, sediment, sewage sludge and water; and
 - (e) Buried pesticides.

II. Relevant provisions of the Basel and Stockholm conventions

A. Basel Convention

86. 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”).

87. 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
 - 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

88. 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.

89. 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)).

90. 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:
 - 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,¹² or unfit for their originally intended use
 - A4040: Wastes from the manufacture, formulation and use of wood-preserving chemicals¹³
 - 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)¹⁴
 - A4080: Wastes of an explosive nature (but excluding such wastes specified on list B)

91. 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

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

¹² “Outdated” means unused within the period recommended by the manufacturer.

¹³ This entry does not include wood treated with wood-preserving chemicals.

¹⁴ 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.

- (a) B1010: Metal and metal-alloy wastes in metallic, non-dispersible form,¹⁵ 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 constituents¹⁶ 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) B3010: Solid plastic waste¹⁷;
- (f) B3020: Paper, paperboard and paper product wastes¹⁸;
- (g) B3030: Textile waste¹⁹;
- (h) B3050: Untreated cork and wood waste.²⁰

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

B. Stockholm Convention

94. For HCB, 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.

95. 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

96. 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 definition of low POP content for alpha-HCH, beta-HCH and lindane is 50 mg/kg as a sum²¹.

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

¹⁵ Refer to Annex IX to the Basel Convention to see the full entry.

¹⁶ *Ibid.*

¹⁷ *Ibid* 15.

¹⁸ *Ibid* 15.

¹⁹ *Ibid* 15.

²⁰ *Ibid* 15.

²¹ 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.

98. Wastes with a content of 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 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.

99. Wastes with a content of 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 below 50 mg/kg should be disposed of in accordance with the methods referred to in section IV.G.4.

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

B. Levels of destruction and irreversible transformation

101. 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

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

IV. Guidance on environmentally sound management (ESM)

A. General considerations

103. See subsection IV.A of the general technical guidelines.

B. Legislative and regulatory framework

104. 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.

105. 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;
- (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;²²
- (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;

²² 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).

- (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; and
- (l) Other legislative measures on, e.g., waste prevention and minimization, inventory development and emergency response.

106. 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.

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

C. Waste prevention and minimization

108. 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.

109. 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.

110. The mixing and blending of wastes with a pesticide POP content above the low POP content defined in paragraph 96 above with other materials solely for the purpose of generating a mixture with a POP content at or 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.

111. For further information, see paragraph 69 and section IV.C of the general technical guidelines.

D. Identification of wastes

112. 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.

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

1. Identification

114. 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).

115. 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; and
- (h) In commercial products containing pesticide POPs, such as paints, household insect sprays, mosquito coils and mosquito nets.

116. 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 52, 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 52, subparagraph (b) above.

117. 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

118. 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.

119. 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

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

1. Sampling

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

122. 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.

123. 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

124. 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). PFOS and precursors require a combination of liquid chromatograph to preferentially tandem mass spectrometers.

3. Monitoring

125. 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

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

1. Handling

127. 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.

128. 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, 2009 and 2011).

2. Collection

129. 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.

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

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

3. Packaging, labelling and transportation

132. 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 below:

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)

133. 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, 2009 and 2011), and in the detailed guidance provided by in the transport regulations and guidelines listed in table 2 above.

134. 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.

135. 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.

136. 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).

137. 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.

138. 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.

139. 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 above, and with the Globally Harmonized System for Classification and Labelling of Chemicals (GHS).

4. Storage

140. Although generally there are few specific regulations or guidelines regarding the storage of pesticide POPs, 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, 2009 and 2011), should be followed as minimum standards. In addition, pesticide POPs should be stored 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

141. 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. Contaminated empty steel drums can be crushed, while contaminated empty plastic containers are amenable to cutting or shredding;

(b) Low temperature thermal desorption (LTTD): LTTD has been used successfully to pre-treat soils heavily contaminated with pesticides. 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 can be condensed and repackaged so that they are suitable for transportation to a destruction facility.

(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” (Final Draft July 2014).²³

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

2. Destruction and irreversible transformation methods

143. In accordance with the general technical guidelines, destruction and irreversible transformation methods for the ESM of wastes containing at least one of the pesticide POPs subject to the present guidelines above the low POP contents set out in paragraph 96 above include:

- (a) Alkali metal reduction (only for chlordane and HCH);
- (b) Base catalyzed decomposition (only for chlordane and HCH);
- (c) Cement kiln co-incineration;
- (d) Gas phase chemical reduction (only for HCB);
- (e) Hazardous waste incineration;
- (f) Plasma arc (most pesticides including chlordane, chlordecone, endosulfan, heptachlor);

and

- (g) Supercritical water oxidation and subcritical water oxidation (only for chlordane);

144. For detailed information on each of these destruction and irreversible transformation methods applicable to pesticide POPs, 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

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

4. Other disposal methods when the POP content is low

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

H. Remediation of contaminated sites

147. Contaminated soil represents a significant challenge in particular to developing countries and countries with economies in transition. Any remaining stocks of POPs pesticides that were originally listed in 2004 have in many cases leaked as the containers have deteriorated. This has

²³ Available from: <http://eippcb.jrc.ec.europa.eu/reference/> (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).

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.

148. The general technical guidelines in section IV, H describe the processes for identification and assessment of the risks posed by contaminated sites. 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.

149. 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.

150. 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 install physical barriers to prevent contact with the soil surface and to prevent the spread of the contamination underground.

151. 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) and volume 6 (on risk reduction methodologies for contaminated sites). Both of these volumes are due for publication in 2015.

I. Health and safety

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

1. Higher-risk situations

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

2. Lower-risk situations

154. For information, see subsection IV.I.2 of the general technical guidelines.

J. Emergency response

155. Emergency response plans should be in place for pesticide POPs in storage, in transit and at disposal sites. Emergency response plans should also be in place for pesticide POPs that are in service, storage, and transport and at disposal sites. Further information on emergency response plans is provided in section IV.J of the general technical guidelines.

K. Public participation

156. 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; GGDN*;</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-hexachlor-1,4,4a,5,8,8a-hexahydro-1,4,5,8- dimethanonaphthalin 1R,4S,4as,5S,8R,8ar-;</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-1,4,4 a,5,8,8a-hexahydro-, (1alpha,4alpha,4abe</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>1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abet</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>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 then 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>Aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-(1.alpha.,4.alpha.,4a.beta.,5.alpha.,8.al)]; Aldrite; Aldrosol; Altox; Alvit 55; Compound 118; 4:5,8-Dimethanonaphthalene; 22DN*; Drinox; Eldrin; ENT-15949; Eruzin*; exo-Hexachlorodimethanonaphthalene; Hexachlorhexahydro-dimethanonaphthaline;</p> <p>Hexachlorohexahydro-endo, exo-dimethanonaphthalene;</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>HHDM; HHDN; HHPN; Kartofin*; Kortofin; Latka 118; NA 2761; NA 2762; NCI-C00044; OMS-194; Octalene; Octalin*; Seedrin; SD 2794; Sojedinenie (= compound) 118*; Tatuzinho; Tipula; Veratox*</p>

Chemical	Some synonyms and trade names ^a
Alpha HCH (CAS No. 319-84-6)	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; alpha-benzene hexachloride, alpha-BHC, alpha-HCH, alpha-lindane; benzene-transhexachloride, Hexachlorocyclohexane-Alpha Benzene hexachloride-alpha-isomer, Alpha-Benzenehexachloride. Alpha-BHC, Cyclohexane. 1,2,3,4,5,6 Hexachloro-alpha. Cyclohexane, alpha-1,2,3,4,5-Hexachloro. ENT 9,232
Beta HCH (CAS No. 319-85-7)	beta-1,2,3,4,5,6-Hexachlorocyclohexane: beta-Benzenehexachloride, beta-BHC, 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-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); Trade names AG Chlordane; Aspon; Aspon-Chlordane; Belt; CD 68; chloordaan, zuiver; chlordan, kemisk rent; Chlordan, rein; Chlordane; Chlordane (gamma); chlordan, 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; 4,7-methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-; 4,7-methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-; Niran; Octachlor; 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-; Octa-Klor; Oktaterr; Ortho-Klor; SD 5532; Shell SD-5532; Starchlor; Synklor; Tat chlor 4; t-chlordan; Topichlor; Topichlor 20; Toxichlor; Unexan-koeder; Veliscol-1068
Chlordecone (CAS No. 143-50-0)	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 (CAS Chemical name) 1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5a,5b,6-decachlorooctahydro- Trade names GC 1189, Kepone, Merex, chlordecone, curlone

Chemical	Some synonyms and trade names ^a
Dieldrin (CAS No. 60-57-1)	<p>(1alpha,2beta,2alpha,3beta,6beta,6alpha,7beta,7alpha- 2,7:3,6-Dimethano-3,4,5,6,9,9-hexachlor-1a,2,2;</p> <p>(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;</p> <p>(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;</p> <p>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</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-exo-dimethano-naphthalene</p> <p>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</p> <p>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,;</p> <p>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-,(1aalp);</p> <p>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-;</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>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;</p> <p>Trade names</p> <p>Aldrin epoxide; Alvit; Alvit 55; Compound 497; D-31; Diel'drin*; Dieldrin; Dieldrin, dry weight;</p> <p>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;</p> <p>Hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene;</p> <p>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-;</p> <p>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);</p> <p>Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene, 1,2,3,4,10,10-;</p> <p>Hexachloro-epoxyoctahydro-dimethanonaphthalene;</p> <p>HOED; Illoxol; Insektalox*; Insecticide No. 497; Insectlack; Kombi-Albertan; Lakta 497; Moth Snub D;</p> <p>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.; (1a.alpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7a.alpha)-2,7;3,6-dimethano-3,4,5,6,9,9-hexachlor-1a; (1A.alpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7A.alpha)3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-; (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; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-; 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; 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; 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; 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; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen; 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; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-5,8-dimethanonaphthalen; 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; 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; 1,2,3,4,10,10-hexachloro-1r,4s,4as,5s,6,7r,8r,8ar-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene; 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalen; 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; 1,2,3,4,10,10-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-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalen; 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; 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; 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; 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-hexachloro-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>Trade names</p> <p>Endrex; Endrin; Endrin 20; Endrin mixture; endrin,endo-endo-isomeres; Endrina; Endrine; ENT-17251;</p> <p>Experimental Insecticide No. 269; Hexachlor;</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-dimethano-octahydronaphthalin;</p> <p>Hexachloroxido-endo-endo-dimethano-octahydronaphthalene;</p> <p>hexachloroxidotetracyclododecen;</p> <p>hexachloräpoxyoctahydro-bis(endo-methylen)naphthalin;</p> <p>Hexachloroepoxyoctahydro-endo,endo-dimethanonaphthalene; Hexadrin; Isodrin Epoxide; Lakta 269;</p> <p>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>Trade names</p> <p>Aahepta; Arbinex 30TN; Agronex Hepta; Agronex Hepta T 30; Agroceres; Basaklor;</p> <p>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; Heptachlor [1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methano-1H-indene]; Heptacloro; Heptachlorotetrahydro-4,7-methanoindene; Heptagran; Heptagranox; Heptamak; Heptamul; Heptasol; Heptox;</p> <p>Latka 104; NCI-C00180; Soleptax; Rhodiachlor; 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; GChB*; Gexachlorbenzol*; Granox; Granox nm; HCB; HCBz;</p> <p>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>Snieciotox; Snieciotox 40; Zaprawa nasienna snieciotox;</p>

Chemical	Some synonyms and trade names ^a
Lindane (CAS No. 58-89-9)	Trade names gamma benzene hexachloride; gamma-BHC Agroicide, 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, Nocochloran, Novigam, Omnitox, Quellada, Silvanol, Tri-6, Vitron.
Mirex (CAS No. 2385-85-5)	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(5.2.1.0'2,6.0'3,9.0'5,8)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(5.2.1.0'2,6.0'3,9.0'5,8)decane; Dodecachloropentacyclo<5.2.1.0 per cent 2,6.0 per cent 3,9.0 per cent 5,8>decane; Dodecacloropentaciclo(5.2.1.0'2,6.0'3,9.0'5,8)decano; ENT-25719; Ferriamicide; GC1283; Hexachloropentadiene Dimer, Hexachloro-1,3-cyclopentadiene dimer; Hrs 1276, NCI-C06428; Paramex; Perchlordecone, Perchloropentacyclodecane; Perchloropentacyclo(5.2.1.02,6.03,9.05,8)decane; Perchlorodihomocubane
Perfluorooctane sulfonate (CAS No.1763-23-1)	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; Perfluoro-noctanesulfonic acid; Perfluorooctanesulfonic acid; Perfluorooctylsulfonic acid
Technical endosulfan (CAS No. 115-29-7)	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 , Trade names Afidan, Benzoepin , Beosit , BIO 5462 , Chlorthiepin , Crisulfan , Cyclodan , Endocel , Endosol , Endossulfam , Endossulf?o , Endosulfan , Endosulfan , ENDOSULFAN (MIXED ISOMERS) , Endosulfan (mixture of alpha and beta isomers) , Endosulfan 35EC , Endosulphan , Endosulfn , ENT-23979 , FMC 5462 , Hexachlorohexahydromethano-2,4,3-benzodioxathiepin-3-oxide , Hildan , HOE 2671 , Insectophene , Kop-Thiodan , Malix , Sulfurous acid, cyclic ester with 1,4,5,6,7,7-hexachloro-5-norbornene-2,3-dimethanol , Thifor , Thimul , Cyclodan, Devisulfan, Endocel, Endocide, Endosol, FMC 5462, Hexasulfan, Hildan, Hoe 2671, Insectophene, Malix, Phaser and Thionex.

Chemical	Some synonyms and trade names ^a
Toxaphene (CAS No. 8001-35-2)	2,2-dimethyl-3-methylenbornanchlorid; 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 2,2-dimethyl-3-methylenbornan; 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; Dimethyl-3-methylenbornanchlorid, 2,2-; 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; Penphene; 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

^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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