

**Technical guidelines on the environmentally sound management 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**

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## Abbreviations and acronyms

ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
ATSDR	Agency for Toxic Substances and Disease Registry
BAT	best available techniques
BEP	best environmental practices
DDT	1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (dichlorodiphenyltrichloroethane)
EPA	Environmental Protection Agency (United States of America)
ESM	environmentally sound management
EXTOXNET	Extension Toxicology Network
FAO	Food and Agriculture Organization of the United Nations
GC	gas chromatography
HCB	hexachlorobenzene
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
IARC	International Agency for Research on Cancer
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
INCHEM	International Programme on Chemical Safety Information on Chemicals
IPCS	International Programme on Chemical Safety
NTP	National Toxicology Program (United States of America)
OECD	Organisation for Economic Co-operation and Development
PCBs	polychlorinated biphenyls
PCCs	polychlorinated camphenes
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
Pesticide POPs	Group of pesticides listed in Annex A of the Stockholm Convention (aldrin, chlordane, dieldrin, endrin, heptachlor, hexachlorobenzene (HCB), mirex and toxaphene) and HCB as an industrial chemical
POP	persistent organic pollutant
RID	International Regulations Concerning the Carriage of Dangerous Goods by Rail
STARS	Stoffdatenbank für Altlasten- /umweltrelevante Stoffe (Substance database for contaminated sites: environmentally relevant substances)
TOXNET	Toxicology Data Network
UNEP	United Nations Environment Programme
WHO	World Health Organization

## Units of measurement

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

# I. Introduction

## A. Scope

1. The present technical guidelines provide guidance 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 (abbreviated as “pesticide POPs”) pursuant to decisions IV/17, V/26, VI/23, VII/13 and VIII/16 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 and OEWG-V/12 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 and SC-2/6 of the Conference of the Parties of the Stockholm Convention.
2. The technical guidelines cover all pesticides listed as persistent organic pollutants (POPs) in Annex A of the Stockholm Convention. The pesticide 1,1,1-trichloro-2,2-bis(4-chlorophenyl)ethane (dichlorodiphenyltrichloroethane – DDT) is covered by Annex B of the Stockholm Convention in consideration of its importance for malaria vector control in many tropical countries and is in the subject of separate technical guidelines (UNEP, 2006a).
3. 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.
4. Unintentionally produced HCB is not covered by these technical guidelines. It is covered in the technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with unintentionally produced PCDDs, PCDFs, HCB or PCBs (UNEP, 2006b).
5. The present document should be used in conjunction with the document entitled “*General technical guidelines for environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants*” (“the general technical guidelines”) (UNEP, 2006c). That document provides more detailed information on the nature and occurrence of wastes consisting of, containing or contaminated with pesticide POPs for purposes of their identification and management.

## B. Description, production, use and wastes

### 1. Aldrin

#### (a) Description

6. Aldrin (CAS no. 309-00-2) takes the form of white, odourless crystals when it is pure. Technical grades are tan to dark brown with a mild chemical odour (Ritter et al., 1995). Aldrin contains no less than 95 per cent 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-endo-1,4-exo-5,8-dimethanonaphthalene (HHDN). HHDN is a white, crystalline, odourless solid with a melting point of 104–104.5°C. Technical aldrin is a tan to dark brown solid with a melting range from 49 to 60°C. It 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). Pure aldrin is stable at < 200°C and within a pH range from pH 4 to pH 8; however, oxidizing agents and concentrated acids attack the unchlorinated ring under any conditions. Aldrin is non-corrosive or slightly corrosive to metals because of the slow formation of hydrogen chloride during storage. Aldrin and dieldrin (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, CAS no. 60-57-1) are the common names of two insecticides which are chemically closely related. Aldrin is readily converted to dieldrin in the environment (Global Pesticides Release Database, Environment Canada, no date).

#### (b) Production

7. Aldrin was first synthesized as a pesticide in the United States of America in 1948. Aldrin was manufactured by the Diels-Alder reaction of hexachlorocyclopentadiene with bicyclo[2.2.1]-2,5-heptadiene. The final condensation was usually performed at approximately 120°C and at atmospheric pressure. Excess bicycloheptadiene was removed by distillation. The final product was usually further purified by recrystallization. Commercial manufacture of aldrin began in 1950 and the substance was used throughout the world up to the early 1970s (ATSDR, 2002; UNEP, 2003d).

See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

**(c) Use**

8. Aldrin has been manufactured commercially since 1950 and was used throughout the world up to 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 Mg, but by 1970 use had decreased to 4,720 Mg.

9. In 1970, the United States Department of Agriculture cancelled all uses of aldrin and dieldrin because of the concern that they could cause severe environmental damage to aquatic ecosystems and because of their potentially carcinogenic properties. In early 1971, the United States Environmental Protection Agency (EPA) initiated cancellation proceedings for aldrin and dieldrin but did not order the suspension of aldrin and dieldrin use. In 1972, under the authority of the Federal Insecticide, Fungicide and Rodenticide Act as amended by the Federal Pesticide Control Act of 1972, an EPA order lifted the cancellation of aldrin and dieldrin use in three cases: subsurface ground insertion for termite control; dipping of non-food plant roots and tops; and mothproofing in manufacturing processes using completely closed systems. Most of the information on aldrin is also applicable to dieldrin.

**2. Chlordane**

**(a) Description**

10. 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) (70 per cent), heptachlor, trans-nonachlor and cis-nonachlor (< 1 per cent). Heptachlor is one of the most active components of technical chlordane, which is a viscous, colourless or amber-coloured liquid with a chlorine-like odour. Pure cis-chlordane has a melting point of 106°C and pure trans-chlordane 104°C. They are not soluble in water and are stable in most organic solvents, including petroleum oils. They are unstable in the presence of weak alkalis (ATSDR, 1994; EXTTOXNET, no date; Holoubek et al., 2004; IPCS INCHEM, no date; Ritter et al., 1995; UNEP, 2002a; WHO-FAO, 1978).

**(b) Production**

11. Chlordane is produced by chlorinating cyclopentadiene to form hexachlorocyclopentadiene and condensing the latter with cyclopentadiene to form chlordene. The chlordene is further chlorinated at high temperature and pressure to chlordane (ATSDR, 1994; UNEP, 2003d).

12. The raw materials for the manufacturing process are cyclopentadiene, hexachlorocyclopentadiene and chlorine or some other chlorinating agent. Chlordane is manufactured in a two-step reaction. In the first step, hexachlorocyclopentadiene reacts with cyclopentadiene in a Diels-Alder reaction. The reaction is exothermic and proceeds readily at a temperature of up to about 100°C. The intermediate is called chlordene. In the next step, chlorine is added to the unsubstituted double bond. Various chlorinating agents, e.g., sulphuryl chloride and catalysts such as ferrous chloride, have been described as making addition dominant over substitution, but it is believed that only chlorine is used in actual practice (De Bruin, 1979). See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

**(c) Use**

13. Chlordane, which was introduced onto the market for the first time in 1945, is a broad-spectrum contact insecticide which 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). In China, chlordane is still used as a termiticide in buildings and dams (UNEP, 2002b).

14. In 1988, the commercial use of chlordane was cancelled in the United States of America. Between 1983 and 1988 the sole and core use for chlordane was to control subterranean termites. For that purpose, chlordane was applied primarily as a liquid which was poured or injected around the foundations of buildings. Chlordane, in conjunction with heptachlor, was at one time widely used as a pesticide for the control of insects on various types of agricultural crops and other vegetation. The use pattern for chlordane in the mid-1970s was as follows: 35 per cent was used by pest control operators, mostly on termites; 28 per cent was used on agricultural crops, including maize and citrus; 30 per cent was used for home lawn and garden use; and 7 per cent was used on turf and ornamentals. In 1978, a final cancellation notice was issued which called for the suspension of the use of chlordane except for

subsurface injection to control termites and for dipping roots and tops of non-food plants. Minor use of chlordane for treating non-food plants was cancelled by 1983. The use of chlordane decreased drastically in the 1970s when EPA cancelled all uses other than subterranean termite control (ATSDR, 1994).

### **3. Dieldrin**

#### **(a) Description**

15. 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 pure major ingredient, HEOD, is a white crystalline solid with a melting point of 176–177°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**

16. Dieldrin was manufactured by epoxidation of aldrin. The epoxidation of aldrin was obtained by reaction with a peracid (producing dieldrin and an acid by-product) or with hydrogen peroxide and a tungstic oxide catalyst (producing dieldrin and water). Peracetic acid and perbenzoic acid were generally used as the peracid. When using a peracid, the epoxidation reaction was performed non-catalytically or with an acid catalyst such as sulphuric acid or phosphoric acid. When using hydrogen peroxide, the catalyst was generally tungsten trioxide (ATSDR, 2002; UNEP, 2003d). See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

#### **(c) Use (see also aldrin)**

17. Dieldrin was mainly used for the control of soil insects such as corn rootworms, wireworms and cutworms (UNEP, 2002a). Also, dieldrin was and is still used in public health protection to control several insect vectors (ATSDR, 2002; Fiedler et al., 2000). In India, its manufacture and import were banned by an order dated 17 July 2001, but marketing and restricted use (locust control) was permitted for a period of two years from the date of the ban, or up to the date of expiry, whichever was earlier. Restricted use of dieldrin is reported from Bangladesh, Myanmar and Nepal (UNEP, 2002c).

### **4. Endrin**

#### **(a) Description**

18. Endrin (CAS no. 72-20-8), when pure, is a white crystalline solid and has a melting point of 200°C. It 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, on exposure to sunlight or on heating above 200°C (ATSDR, 1996; IPCS INCHEM, no date; WHO-FAO, 1975).

#### **(b) Production**

19. Endrin is a stereoisomer of dieldrin produced by the reaction of vinyl chloride and hexachlorocyclopentadiene to yield a product which is then dehydrochlorinated and condensed with cyclopentadiene to produce isodrin. This intermediate is then epoxidized with peracetic or perbenzoic acid to yield endrin. An alternative production method involves condensation of hexachlorocyclopentadiene with acetylene to yield the intermediate for condensation with cyclopentadiene (ATSDR, 1996; UNEP, 2003d).

20. It is estimated that 2,345 Mg of endrin were sold in the United States of America in 1962, whereas under 450 Mg were produced in 1971. More recent estimates of domestic production of endrin could not be found. As with many toxic chemicals, information on production or use of pesticides is often proprietary, and quantitative estimates of production of endrin are almost impossible to obtain. No information on the production of endrin was available from the United States Toxic Release Inventory because endrin is not one of the chemicals on which producers are required to report. Endrin aldehyde and endrin ketone were never commercial products but occurred as impurities of endrin or as degradation products. Whereas commercial preparations of solid endrin were typically 95–98 per cent pure, the following chemicals (in addition to endrin aldehyde and endrin ketone) have been found as trace impurities in commercial endrin products: aldrin, dieldrin, isodrin, heptachloronorborene and heptachloronorborene (HSDB, no date). The active ingredient would often be mixed with one or more organic solvents for application in a liquid form. Carriers included xylene, hexane, and cyclohexane (ATSDR, 1996; UNEP, 2003d). See annex I for a more detailed list of trade names and synonyms and

section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

**(c) Use**

21. Beginning in 1951, 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 a major reason for the cancellation of its use in the United States as a pesticide agent. Except for use as a toxicant on bird perches, which was cancelled in 1991, the manufacturer voluntarily cancelled all other uses of endrin in the United States in 1986. It has been estimated that 6,250 kg of endrin were used annually in the United States before 1983. Both EPA and the United States Food and Drug Administration revoked all food tolerances for endrin in 1993 (ATSDR, 1996; Fiedler et al., 2000).

**5. Heptachlor**

**(a) Description**

22. Pure heptachlor (CAS no. 76-44-8) is a white crystalline solid with a melting point of 95–96°C. Technical heptachlor is a soft, waxy solid with a melting range between 46 and 74°C. It is nearly insoluble in water and slightly soluble in alcohol. It is stable up to temperatures between 150 and 160°C and also 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).

**(b) Production**

23. Heptachlor was first registered for use as an insecticide in the United States of America in 1952. Commercial production began in 1953. Heptachlor is commercially produced by free-radical chlorination of chlordane in benzene containing 0.5 per cent to 5.0 per cent fuller's earth. The production process is run for up to eight hours as the reaction rate is very low. The chlordane starting material is prepared by the Diels-Alder condensation of hexachlorocyclopentadiene with cyclopentadiene. Technical-grade heptachlor usually consists of 72 per cent heptachlor and 28 per cent impurities such as trans-chlordane, cis-chlordane and nonachlor (De Bruin, 1979; ATSDR, 1993). See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

**(c) Use**

24. Heptachlor is a persistent dermal insecticide with some fumigant action. It is non-phytotoxic at insecticidal concentrations. Heptachlor was used extensively from 1953 to 1974 as a soil and seed treatment to protect maize, small grains and sorghum from pests. It was used to control ants, cutworms, maggots, termites, thrips, weevils, and wireworms in both cultivated and uncultivated soils. Heptachlor was also used non-agriculturally during that time period to control termites and household insects (ATSDR, 1993; Fiedler et al., 2000).

**6. Hexachlorobenzene (HCB)**

**(a) Description**

25. Hexachlorobenzene (HCB) (CAS no. 118-74-1) is a chlorinated monocyclic aromatic compound in which the benzene ring is fully substituted by chlorine. HCB is a white crystalline solid (melting point 231°C) which is nearly insoluble in water but is soluble in ether, benzene and chloroform (NTP, 1994). 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 gas 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**

26. The industrial production of HCB is normally by the direct chlorination of benzene at 150–200°C over a ferric chloride catalyst. Other routes which are believed to have been used to some extent are the chlorination of hexachlorocyclohexane isomers with sulphuryl chloride or chlorosulphonic acid in the presence of a ferric chloride or other catalyst, and the distillation of heavy-end residues from perchloroethylene production (Brooks, 1984). Most of the HCB produced was technical-grade material for pesticide use. This contained about 98 per cent HCB. Known impurities in technical-grade HCB include 1,2,4,5-tetrachlorobenzene, pentachlorobenzene, decachlorobiphenyl and the higher congeners (tetrachloro- and above) of the PCDDs and PCDFs (IPCS, 1997). Smaller quantities, usually of purer HCB, were produced for other industrial uses and as a chemical intermediate

for the production of other chemicals. See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

27. Industrial production of HCB began in 1945 in the United States of America. It was subsequently produced in Canada, Mexico, Europe (former Czechoslovakia, Germany), India and the former Union of Soviet Socialist Republics, and possibly elsewhere. Global production reached 1,000–2,000 Mg per year by the early 1970s and is believed to have peaked at some 10,000 Mg per year in the late 1970s and early 1980s (Barber et al., 2005; Rippen and Frank, 1986). Approximately 80 per cent of HCB production in 1978 is believed to have been in Europe (Rippen and Frank, 1986). Production of HCB has declined as a result of restrictions on its use starting in the 1970s. In the United States, 360 Mg per year was used around 1960 and an estimated 300 Mg was produced by three manufacturers in the United States in 1973 (IARC, 1979). United States production in 1977 was 454 Mg (SMOC Mexico, 1998). HCB was produced at a maximum rate of 3,500 Mg per year in Mexico in the 1970s, with a total of 39,000 Mg produced between 1970 and the end of production in 1991 (SMOC Mexico, 1998). Most of that HCB was used within Mexico for agricultural purposes, with significant use continuing right up until it was banned in 1992 (SMOC Mexico, 1998). Approximately 1,500 Mg of HCB were manufactured annually in Germany for the production of the rubber auxiliary pentachlorothiophenol (IPCS, 1997), but this production was discontinued in 1993. In Germany HCB was produced at rates of approximately 4,000 Mg per year in 1974 and 2,600 Mg per year in 1976 (Rippen and Frank, 1986). In former Czechoslovakia, HCB production was terminated in Spolana Neratovice (Czech Republic) in 1968. No further centres of HCB manufacture in Europe or North America have been identified. India produced 42,612 Mg of technical-grade HCB during 1995–1997 (Ministry of Chemicals and Fertilisers, 2000). About 15,390 Mg of HCB were imported by Pakistan during 1970–1992 and 12,162 Mg was used (1979–1988). There is evidence that HCB is still produced commercially in China. There is no information on the current state of HCB production in the countries of the former Union of Soviet Socialist Republics. Although HCB has continued to be offered for sale in the Russian Federation, it is unclear whether this arises from domestic production or is imported and re-exported.

28. HCB is also produced as a by-product of the manufacture of perchloroethylene (also known as tetrachloroethylene, PER or PERC), carbon tetrachloride and, to some extent, trichloroethylene (Government of Canada, 1993). In some cases, there is a potential for the production of significant quantities. Historically, when and where HCB had commercial value the by-product stream was isolated as a “heavy” fraction from distillation operations and purified to yield intentionally produced technical-grade HCB for sale as a pesticide. As a result, substantial quantities of HCB may be contained in the wastes generated through the past manufacture of such chlorinated solvents. In the 1980s, the concentration of HCB in distillation “heavies” was estimated to be between 5 per cent and 25 per cent by weight (Jacoff, 1986). There are at least two identified stockpiles of over 10,000 Mg of waste HCB, one in Australia and the other in Ukraine. It is reasonable to assume that there are other smaller stockpiles elsewhere associated with similar historical manufacturing operations. The present-day manufacture of chlorinated solvents, however, gives rise to only trace quantities of HCB.

(c) **Use**

29. Historically, the major use of HCB was as a fungicide. It was used worldwide as an agricultural fungicide from early in the twentieth century, particularly as a seed dressing to prevent fungal diseases of grain and other field crops. Its use in the former Soviet Union was particularly extensive and has given rise to significant environmental concerns in the countries of that region. Pesticide uses of HCB have now been effectively discontinued in most countries, with reductions beginning in the 1970s and near-complete phase-out by the early 1990s. Emissions of “old” pesticide HCB is, however, believed to be continuing from soils, stockpiles and wastes.

30. HCB was used extensively as a fungicide to control bunt (*Tilletia caries*, *T. tritici* and *T. foetida*) in wheat, representing a major breakthrough for that disease. HCB was applied as a dust. There is little information available as to the amounts of HCB which were used for that purpose, however. HCB was used briefly as a fungicide in small quantities in Australia and New Zealand in the 1960s and 1970s. In the 1960s in Australia, 12 million bushels (326.6 million Mg) of seed wheat were treated annually with HCB dust, requiring 200 Mg of technical HCB (FAO-WHO, 1970). A smaller proportion of the total crop was probably treated in the Canada, the United States, the United Kingdom and some other European countries, but there was extensive use in France, Germany, Italy, the Netherlands Spain and Turkey and also in some Eastern European countries (FAO-WHO, 1970). Approximately 610 Mg were used in the former Soviet Union until HCB was banned for agricultural purposes in 1986. In Canada, HCB was used as a seed dressing for several crops from 1948 to 1972.

31. Industrial uses, including as a chemical intermediate, represent a relatively small proportion of cumulative global production. However, those uses have not declined as rapidly as the pesticide applications and the relatively small remaining production is probably mostly for non-pesticide use.

32. Historically there were a number of potentially dispersive non-pesticide end uses for HCB. It was used as a wood preservative, for impregnating paper, as a means of controlling porosity in the manufacture of graphite electrodes for electrolytic processes, as a fluxing agent in the manufacture of aluminium and in the formulation of military pyrotechnic products and tracer bullets. Those uses have been discontinued almost completely and the only reference found to end-product use since 2000 is in pyrotechnic and smoke-generating products in the Russian Federation (Shekhovtsov, 2002).

33. HCB has also been used as a chemical intermediate in the manufacture of other substances, as in its use as a peptizing agent in the production of nitroso- and styrene rubbers for use in vehicle tyres (Mumma and Lawless, 1975). Other uses as a chemical intermediate have included the manufacture of certain dyestuffs (ATSDR, 2002), 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) except China (Kunisue et al., 2004) and the Russian Federation.

## **7. Mirex**

### **(a) Description**

34. Mirex (CAS no. 2385-85-5) is a white, odourless crystalline substance with a melting point of 485°C and as such is fire-resistant. It 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 is nearly insoluble in water. Mirex is considered to be extremely stable. It does not react with sulphuric, nitric, hydrochloric or other common acids and is unreactive with bases, chlorine and ozone. In the environment, it degrades to photomirex when exposed to sunlight (ATSDR, 1995; IPCS, 1997; EPA, 2000b).

### **(b) Production**

35. Although it was originally synthesized in 1946, mirex was not commercially introduced in the United States of America until 1959, when it was produced under the name GC-1283 for use in pesticide formulations and as an industrial fire retardant under the trade name Dechlorane®. Mirex was produced by the dimerization of hexachlorocyclopentadiene in the presence of an aluminium chloride catalyst (ATSDR, 1995). Technical-grade preparations of mirex contained about 95 per cent mirex with about 2.6 mg/kg chlordecone as a contaminant. Several formulations of mirex were prepared in the past for various pesticide uses. Some of the more commonly used formulations of mirex used as bait were made from ground maize cobs (maize cob grit) impregnated with vegetable oil and various concentrations of mirex. Insect bait formulations for aerial or ground applications contained 0.3–0.5 per cent mirex, and fire ant formulations contained 0.075–0.3 per cent mirex (IARC, 1979). See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

### **(c) Use**

36. Because it is non-flammable, mirex was marketed as a flame retardant additive in the United States of America from 1959 to 1972 under the trade name Dechlorane® for use in various coatings, plastics, rubber, paint, paper and electrical goods.

37. Mirex was most commonly used in the 1960s as an insecticide to control the imported fire ant in nine southern states of the United States. Mirex was chosen for fire ant eradication programmes because of its effectiveness and selectiveness for ants. It was originally applied aerially at concentrations of 0.3–0.5 per cent. However, aerial application of mirex was replaced by mound application because of suspected toxicity to estuarine species. Also, the goal of the fire ant programme was altered from eradication to selective control. Mirex was also used successfully in controlling populations of leaf cutter ants in South America, harvester termites in South Africa, western harvester ants in the United States, mealybugs in pineapples in Hawaii, and common (yellowjacket) wasps in the United States. All registered products containing mirex were effectively cancelled in December 1977. Selected ground application, however, was allowed until June 1978, at which time the product was banned in the United States with the exception of continued use in Hawaii on pineapples until stocks on hand were exhausted.

38. China has applied for an exemption from the Stockholm Convention for the production and use of mirex as a termiticide. There is limited production and some local use for that purpose (ATSDR, 1995; UNEP, 2002b).

## 8. Toxaphene

### (a) Description

39. Toxaphene (CAS no. 8001-35-2) is an insecticide containing over 670 polychlorinated bicyclic terpenes consisting predominantly of chlorinated camphenes. Toxaphene formulations included wettable powders, emulsifiable concentrates, dusts, granules, baits, oils, and emulsions (IARC, 1979; ATSDR, 1996). In its original form, it is a yellow to amber waxy solid which smells like turpentine (see below). Its melting range is from 65 to 90 °C. Its boiling point in water is above 120°C, which is the temperature at which it starts to decompose. Toxaphene tends to evaporate when in solid form or when mixed with liquids and does not burn. Toxaphene is also known as camphechlor, chlorocamphene, polychlorocamphene and chlorinated camphene (ATSDR, 1996; Fiedler et al., 2000; IPCS INCHEM, no date; EPA, 2000b).

### (b) Production

40. Technical toxaphene can be produced commercially by reacting chlorine gas with technical camphene in the presence of ultraviolet radiation and catalysts, yielding chlorinated camphene containing 67–69 per cent chlorine by weight. It has been made available in various forms: a solid containing 100 per cent technical toxaphene; a 90 per cent solution in xylene or oil; a wettable powder containing 40 per cent toxaphene; dusts containing 5–20 per cent and 40 per cent toxaphene; granules containing 10 or 20 per cent toxaphene; emulsifiable concentrates in concentrations of 4, 6 and 9 per cent toxaphene; baits containing 1 per cent toxaphene; a 2:1 toxaphene:DDT emulsion; and a dust containing 14 per cent toxaphene and 7 per cent DDT. In 1982, EPA cancelled the registrations of toxaphene for most uses as a pesticide or pesticide ingredient, except for certain uses under specific terms and conditions (ATSDR, 1996).

41. Especially in the United States of America, the definition of “technical toxaphene” was patterned after the Hercules Incorporated product (Hercules code number 3956) marketed under the trademark name “Toxaphene”. In recent years, Hercules Incorporated has essentially let the name of toxaphene lapse into the public domain so that many products with similar properties are referred to as toxaphene. Other companies used slightly different manufacturing processes, leading to chlorinated camphene mixtures with degrees of total chlorination and distributions of specific congeners which are not the same as in the Hercules Incorporated product. For example, the toxaphene-like product commonly marketed under names such as “Stroban(e)” had a slightly lower degree of chlorination and used slightly different camphene or pinene feedstocks. In 1996, toxaphene-like pesticide agents were still being produced and were in wide use in many countries. Although it is impossible to quantify production figures or usage rates, India and many countries in Latin America, Eastern Europe, the former Soviet Union and Africa are still using various toxaphene products as pesticides (ATSDR, 1996).

42. Toxaphene was introduced in 1949 and became the most heavily used organochlorine pesticide in the United States until its ban in 1982. High production rates were also reported for Brazil, the former Union of Soviet Socialist Republics and the former German Democratic Republic, and also for Central America (Voldner and Li, 1993). Although most attention has been focused on the intentional production of polychlorinated camphenes (PCCs) as pesticide agents, there is growing evidence that PCC congeners may be an unintentional by-product of manufacturing processes which use chlorination, such as those for paper and pulp. Studies concerning places as far-flung as New Zealand, Japan, the Great Lakes region in the United States and Scandinavia suggest that PCCs can be found in many parts of the world where toxaphene mixtures have never been used as pesticide agents (ATSDR, 1996). See annex I for a more detailed list of trade names and synonyms and section D of chapter IV below for considerations regarding precautions to take when using trade names in inventory exercises.

### (c) Use

43. Toxaphene was one of the most heavily used insecticides in the United States until 1982, when it was cancelled for most uses; all uses were banned in 1990. Voldner and Li (1993) estimated a global usage of 1.3 million Mg from 1950 to 1993.

44. Toxaphene was formerly used as a non-systemic stomach and contact insecticide with some acaricidal activity. Being non-phytotoxic (except to cucurbits), it was used to control many insects thriving on cotton, corn, fruit, vegetables, and small grains and to control the *Cussia obtusifolia* soybean pest. Toxaphene was also used to control livestock ectoparasites such as lice, flies, ticks, mange and scab mites. Its relatively low toxicity to bees and its long-persisting insecticidal effect made it particularly useful in the treatment of flowering plants. Toxaphene was not used to control cockroaches because its action on them is weaker than that of chlordane. Toxaphene was used at one time in the United States to eradicate fish. The principal use was for pest control on cotton crops. In 1974, an estimated 20,000 Mg used in the United States was distributed as follows: 85 per cent on cotton;

7 per cent on livestock and poultry; 5 per cent on other field crops; 3 per cent on soybeans; and under 1 per cent on sorghum. Based on the estimates of von Rumker et al. (1974) for 1972, 75 per cent of the toxaphene production for that year was for agricultural use, 24 per cent was exported and 1 per cent was used for industrial and commercial applications. Toxaphene solutions were often mixed with other pesticides partly because toxaphene solutions appear to help solubilize other insecticides of low water solubility. Toxaphene was frequently applied with methyl or ethyl parathion, DDT or lindane. Until the early 1970s, toxaphene or mixtures of toxaphene with rotenone were used widely in lakes and streams by fish and game agencies to eliminate biological communities which were considered undesirable for sport fishing (ATSDR, 1996).

## 9. Wastes

45. Wastes consisting of, containing or contaminated with pesticide POPs, except HCB as an industrial chemical, are found in a number of physical forms including:

- (a) Obsolete stockpiles of pesticide POPs in original packages which are no longer usable because their shelf life has been exceeded or the packaging has deteriorated;
- (b) Liquid technical-grade pesticide POPs diluted with solvents such as gas oil;
- (c) Solid technical-grade pesticide POPs diluted with inert materials;
- (d) Demolition wastes such as storage walls and slabs, foundations, beams and so forth;
- (e) Equipment such as shelves, spray pumps, hoses, personal protective materials, vehicles and storage tanks;
- (f) Packaging materials such as drums, bags, bottles and gas cylinders;
- (g) Soil, sediment, sewage sludge and water;
- (h) Spent treatment media such as activated carbon;
- (i) Foodstuffs and animal feeds.

46. Wastes consisting of, containing or contaminated with HCB as an industrial chemical are found in a number of physical forms including:

- (a) Solids, sludges, suspensions and solutions containing significant concentrations of HCB (typically > 1,000 mg/kg):
  - (i) Residual material from operations which intentionally produce or use HCB, particularly from discontinued operations (see also subsections I.B.6 (b) and (c));
  - (ii) Residual material from discontinued operations which produced HCB in significant amounts as a by-product from the manufacture of chlorinated solvents, and which may have used that by-product as a source of technical HCB;
- (b) Contaminated wood, paper and plastic materials in which HCB was used for impregnation or as an additive;
- (c) Old graphite electrodes from certain obsolete electrolytic processes;
- (d) Pyrotechnic products and smoke-generating products and equipment of civilian or military origin;
- (e) Solids, sludges, suspensions and solutions containing low concentrations or trace amounts of HCB (typically < 50 mg/kg):
  - (i) Wastes which are contaminated with PCDDs or PCDFs may also be contaminated with HCB;
  - (ii) Residues from the waste treatment of "heavy" fractions occurring as by-products in the manufacture of chlorinated solvents;
  - (iii) Contaminated soils from the vicinity of stockpiles of HCB or of processes which produced HCB intentionally or in significant quantities as an unintended by-product;
  - (iv) Contaminated soil, ground water and biota from the vicinity of dumpsites and landfills used for the disposal of wastes containing high concentrations of HCB;

- (v) Containers contaminated through the storage of waste consisting of, containing or contaminated with HCB.

## II. Relevant provisions of the Basel and Stockholm conventions

### A. Basel Convention

47. Article 1 (“Scope of the Convention”) defines the waste types subject to the Basel Convention. Subparagraph 1 (a) of that Article sets forth a two-step process for determining if a “waste” is a “hazardous waste” subject to the Convention: first, the waste must belong to any category contained in Annex I 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”).

48. Annex I lists some of the wastes which may consist of, contain or be contaminated with pesticide POPs and HCB as an industrial chemical:

- (a) For pesticide POPs, the wastes 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
- (b) For HCB as an industrial chemical, the wastes 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

49. Wastes listed in Annex I are presumed to exhibit an Annex III hazardous characteristic such as 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 a particular hazardous characteristic listed in Annex III until such time as the hazardous characteristic is fully defined. Guidance papers for each Annex III hazardous characteristic are currently being developed under the Basel Convention.

50. List A of Annex VIII describes wastes which are “characterized as hazardous under Article 1 paragraph 1 (a) of this Convention” although “Designation of a waste on Annex VIII does not preclude the use of Annex III (hazard characteristics) to demonstrate that a waste is not hazardous” (Annex I, paragraph (b)). List B of Annex IX lists wastes which “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”. The following Annex VIII waste categories are applicable to pesticide POPs and HCB as an industrial chemical:

- (a) For 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,<sup>1</sup> or unfit for their originally intended use

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<sup>1</sup> “Outdated” means unused within the period recommended by the manufacturer.

A4040 Wastes from the manufacture, formulation and use of wood-preserving chemicals<sup>2</sup>

A4080 Wastes of an explosive nature (but excluding such wastes specified on list B)

(b) For 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)<sup>3</sup>

A4080 Wastes of an explosive nature (but excluding such wastes specified on list B)

51. Annex VIII includes a number of wastes or waste categories which have the potential to contain or be contaminated:

(a) With 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<sup>1</sup> chemicals corresponding to Annex I categories and exhibiting Annex III hazard characteristics

(b) With 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-dioxin

A4130 Waste packages and containers containing Annex I substances in concentrations sufficient to exhibit Annex III hazard characteristics

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

## **B. Stockholm Convention**

53. The Stockholm Convention aims to eliminate all pesticide POPs listed in its Annex A. Nevertheless, under Article 4 of the Convention, any State may, on becoming a Party, by means of a notification in writing to the Secretariat, register for one or more types of specific exemptions listed in Annex A. Article 4 also establishes a register for the purpose of identifying the Parties which have specific exemptions listed in Annex A. The register for specific exemptions is maintained by the Secretariat and is available to the public at [www.pops.int](http://www.pops.int). All registrations of specific exemptions must expire five years after the date of entry into force of the Stockholm Convention for that Party. The Conference of the Parties may, upon request from the Party concerned, decide to extend the expiry date of a specific exemption for a period of up to five years.

54. 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.

55. For further information, see section II.B.2 of the general technical guidelines.

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<sup>2</sup> This entry does not include wood treated with wood-preserving chemicals.

<sup>3</sup> 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.

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

#### **A. Low POP content**

56. The following provisional definition for low POP content should be applied for aldrin, chlordane, dieldrin, endrin, heptachlor, HCB, mirex and toxaphene: 50 mg/kg each/individually.<sup>4</sup> For further information, see section III.A of the general technical guidelines.

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

57. For the provisional definition of levels of destruction and irreversible transformation, see section III.B of the general technical guidelines.

#### **C. Methods which constitute environmentally sound disposal**

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

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

#### **A. General considerations: Basel and Stockholm conventions and Organisation for Economic Co-operation and Development**

##### **1. Basel Convention**

59. One of the principal vehicles for the promotion of ESM is the preparation and dissemination of technical guidelines such as the present document and the general technical guidelines. For further information see subsection IV.A.1 of the general technical guidelines.

60. Parties planning or reviewing a national ESM programme should consult, inter alia, *Destruction and Decontamination Technologies for PCBs and Other POPs Wastes under the Basel Convention*, vols. A, B and C (UNEP, 2001).

##### **2. Stockholm Convention**

61. The term “environmentally sound management” is not defined in the Stockholm Convention. Environmentally sound methods for disposal of wastes consisting of, containing or contaminated with pesticide POPs are, however, to be determined by the Conference of the Parties in cooperation with the appropriate bodies of the Basel Convention.

62. Parties should consult *Interim Guidance for Developing a National Implementation Plan for the Stockholm Convention* (UNEP, 2004c).

##### **3. Organisation for Economic Co-operation and Development**

63. For information regarding the Organisation for Economic Co-operation and Development and ESM, see subsection IV.A.3 of the general technical guidelines.

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

64. Parties to the Basel and Stockholm conventions should examine national controls, standards and procedures to ensure that they are in keeping with the respective conventions and with their obligations under them, including those which pertain to ESM of wastes consisting of, containing or contaminated with pesticide POPs.

65. Elements of a regulatory framework applicable to pesticide POPs could also include the following:

- (a) Environmental protection legislation setting release limits and mandating environmental quality criteria;
- (b) Prohibitions on the manufacture, sale, import and export (for use) of pesticide POPs;
- (c) Phase-out dates for pesticide POPs which are in use or in stock;
- (d) Transportation requirements for hazardous materials and waste;
- (e) Specifications for containers, equipment, bulk containers and storage sites;

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<sup>4</sup> Determined according to national or international methods and standards.

- (f) Specification of acceptable analytical and sampling methods for pesticide POPs;
- (g) Requirements for waste management and disposal facilities;
- (h) A general requirement for public notification and review of proposed government regulations, policy, certificates of approval, licences, inventory information and national releases data;
- (i) Requirements for identification and remediation of contaminated sites;
- (j) Requirements for health and safety of workers;
- (k) Other potential legislative controls, as for waste prevention and minimization, inventory development and emergency response.

66. A link should be established in legislation between the phase-out dates for production and use of pesticide POPs (including in products and articles) and the disposal of the pesticide POPs once they have become waste. The legislation should include a time limit for disposal of wastes consisting of, containing or contaminated with pesticide POPs so as to prevent the creation of stockpiles which have no clear phase-out date.

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

## C. Waste prevention and minimization

68. Both the Basel and Stockholm conventions advocate waste prevention and minimization, while pesticide POPs are targeted in the Stockholm Convention for complete elimination. Pesticide POPs should be taken out of service and disposed of in an environmentally sound manner. Pesticide producers, formulators and users of products and articles containing pesticide POPs may be required to develop waste management plans which cover all hazardous wastes, including wastes consisting of, containing or contaminated with pesticide POPs. The issue of waste prevention and minimization is being considered by the Stockholm Convention Expert Group on Best Available Techniques and Best Environmental Practices; in that connection, see also the draft *Guidelines on best available techniques and provisional guidance on best environmental practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants* (UNEP, 2006). A final text of the guidelines is expected to be adopted by the Conference of the Parties of the Stockholm Convention in mid-2007.

69. Quantities of waste containing pesticide POPs should be 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 which have undergone deterioration, the risks of further damage to the environment and population should be minimized as soon as possible and the following options should be considered:

- (a) Stabilization of the site: leaking pesticides should be segregated and repacked;
- (b) Reduction of the number of storage sites, repackaging of pesticide POPs and safe storage at a limited number of centralized storage sites.

70. Mixing of wastes with a pesticide POPs content above a defined low POP content with another material solely for the purpose of generating a mixture with a POP content below the defined low POP content is not environmentally sound. Nevertheless, mixing of materials before waste treatment may be necessary in order to optimize treatment efficiencies.

71. For further information, see paragraph 6 and section IV.C of the general technical guidelines.

72. FAO has developed *Guidelines for the management of small quantities of unwanted and obsolete pesticides* (FAO, 1999) in order to protect farmers and urban dwellers, who often use small quantities of pesticides (as opposed to bulk quantities) and are not aware of the inherent dangers of pesticides.

## D. Identification and inventories

### 1. Identification

73. The identification of pesticide POPs cannot be considered as an isolated activity, even though the pesticide POPs fall under the obligations of the Stockholm Convention. It is highly recommended when identifying pesticide POPs to include other pesticides, particularly DDT, thus making sure that the problem as a whole is taken into account. Present experiences in Africa indicate that between 15 and 30 per cent of obsolete pesticides may be pesticide POPs (ASP, 2004).

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

- (a) In residues from pesticide POP production and at sites where they were produced and formulated;
- (b) In government storage under health and agriculture ministries;
- (c) In storage facilities at farms, stables and other livestock facilities;
- (d) In homes (domestic storage), outlets for drugs and pesticides, shopping centres, schools, hospitals, industrial facilities, office and apartment buildings and so on;
- (e) In contaminated materials including protective clothing, application equipment and accessories, empty packaging materials, containers, floors, walls, windows and mosquito nets;
- (f) At dumpsites and in landfills;
- (g) In soils, sediment and sewage sludge and in water which has been contaminated by spills;
- (h) In commercial products containing pesticide POPs such as paints, household insect sprays and mosquito coils.

75. HCB as industrial chemical is typically found:

- (a) At manufacturing plants which produce HCB;
- (b) In wastes at or arising from manufacturing plants which formerly produced HCB, as described in subsection I.B.6 above,
- (c) In wastes at or arising from manufacturing plants which use or formerly used HCB for those uses discussed in paragraph 31 above;
- (d) In wastes at or arising from manufacturing plants which use or used HCB as a chemical intermediate in the manufacture of the chemicals discussed in paragraph 32 above.

76. 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. Some treatment technologies are extremely sensitive to the presence of other substances, such as metals.

77. In identifying pesticide POPs, the common trade names listed in annex I may be found useful.

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

## **2. Inventories**

79. For information, see subsection IV.D.2 of the general technical guidelines. It is advisable also to refer to the FAO *Pesticide storage and stock control manual* (FAO, 1996), the FAO provisional guidelines entitled “*Prevention of accumulation of obsolete pesticide stocks*” (FAO, 1995) and the draft guidance document entitled “*The preparation of inventories of pesticides and contaminated materials*” (FAO, 2005).

80. 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. In developing a complete inventory, it should be borne in mind that the security of the inventoried site should match the effort put into carrying out the inventory itself. If the inventory is detailed, then the inventoried stock should be secured so that only known additions to or removals from the stock occur and so that contamination of or mixing with other materials is prevented. Consequently, an inventory should also provide a summary of categories of possible destination for pesticide POPs (see, for example, UNEP, 2001).

81. The development of a national inventory also requires a sound administrative process for the collection of information on an ongoing basis in accordance with FAO guidelines and standardized methods.

## **E. Sampling, analysis and monitoring**

82. For general information, see section IV.E of the general technical guidelines.

## **1. Sampling**

83. For information on sampling, see subsection IV.E.1 of the general technical guidelines.

## **2. Analysis**

84. For information on analysis, see subsection IV.E.2 of the general technical guidelines.

## **3. Monitoring**

85. Monitoring programmes should be implemented for facilities managing wastes consisting of, containing or contaminated with pesticide POPs. For further information, see subsection IV.E.3 of the general technical guidelines.

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

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

### **1. Handling**

87. The main concerns when handling wastes consisting of, containing or contaminated with pesticide POPs are human exposure, accidental release to the environment and contamination of other waste streams with pesticide POPs. Such wastes should be handled separately from other waste types in order to prevent contamination of other waste streams. Recommended practices towards that end, and which, as such, should be verified, supervised and monitored, include:

(a) Inspecting containers for leaks, holes, rust, high temperature (resulting from chemical reactions), and appropriate repackaging as necessary;

(b) Handling wastes at temperatures below 25°C, if possible, because of the increased volatility at higher temperatures;

(c) Ensuring that spill containment measures are in good condition and adequate to contain liquid wastes if spilled, i.e., the total volume plus 10 per cent;

(d) Placing plastic sheeting or absorbent mats under containers before opening them if the surface of the containment area is not coated with a smooth surface material (paint, polymers or polymeric resin);

(e) Removing liquid wastes either by removing the drain plug or by pumping using a peristaltic pump (safeguarded against ignition and fire risks) 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 any spills with cloths, paper towels or specific absorbent materials;

(h) Triple rinsing of contaminated empty packaging materials (such as metal drums) with a solvent such as kerosene to remove all residual pesticide POPs so that the rinsed containers can be disposed of for recycling;

(i) Treating all solvents and contaminated absorbent materials from triple rinsing and contaminated disposable protective equipment and plastic sheeting as pesticide wastes.

88. Staff should be trained in the correct methods for handling hazardous wastes using national or international methods and standards and following FAO guidelines (FAO, 2004).

89. For further information, see subsection IV.F.2 of the general technical guidelines.

### **2. Collection**

90. A significant fraction of total national inventories of pesticide POPs may be held in small quantities at small storage sites belonging to farmers' cooperatives, distributors, business owners and homeowners. It is 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 available or no suitable disposal facility available in that country), and costs may be prohibitive. In some countries national, regional and municipal governments may wish to consider establishing collection stations for those small quantities so that each small-quantity owner does not have to make individual transport and disposal arrangements.

91. Collection depots and collection activities related to pesticide POPs should be managed according to appropriate guidelines and separately from those for all other wastes if necessary.

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

93. For further information, see subsection IV.F.2 of the general technical guidelines.

### 3. Packaging

94. Wastes consisting of, containing or contaminated with pesticide POPs should be properly packaged before storage or transport:

(a) Liquid wastes should be placed in double-bung steel drums or other approved containers;

(b) Regulations governing transport often specify containers of a certain quality (e.g., 16-gauge steel coated on the inside with epoxy resins); consequently, containers used for storage should meet transport requirements given that they may be transported in the future;

(c) Large amounts of wastes or equipment consisting of, containing or contaminated with pesticide POPs may be placed inside large containers (overpack drums) or heavy plastic wrap if leakage is a concern;

(d) Small pieces of equipment, whether drained or not, should be placed in drums with an absorbent material. Numerous small pieces of equipment may be placed in the same drum so long as an adequate amount of absorbent material is present in the drum. Loose absorbents may be purchased from safety suppliers. Sawdust, vermiculite or peat moss may also be used;

(e) Drums and equipment may be placed on pallets for movement by forklift truck and for storage. Drums and equipment should be strapped to the pallets before they are moved.

95. Waste packages and consignments must be handled in a manner which prevents damage during processing, loading and transportation and must conform to the national and international requirements of the relevant legislation.

96. Repackaged pesticide POPs wastes should be fixed with wooden structures and/or straps in sea containers before shipping. Repackaging should be carried out in such a way that different types of hazard represented by the chemicals are not mixed. Packaging materials to be used in the European Union should comply with ADR 2005 (the latest European Agreement concerning the International Carriage of Dangerous Goods by Road). Certificates of packaging material should always be checked.

97. Adequate precautions should be taken to ensure that pesticide containers cannot be used for other purposes, particularly the storage of food or water for human or animal consumption.

98. The United Nations (UN) codes<sup>5</sup> normally used on packaging materials for pesticide POPs (which should be embossed on steel drums, printed on plastic bags and so on) are as follows:

UN1H1/..... for polyethylene drums for liquid wastes (closed top)

UN1H2/..... for polyethylene drums for solid wastes (open top)

UN1A1/..... for steel drums for liquid wastes (closed top)

UN1A2/..... for steel drums for solid wastes (open top)

99. Certificates for the UN code used should be requested from the contractor. In the event that no UN codes are visible on new packaging materials, the materials should be considered as not being United Nations approved.

100. In packaging for air transport, the International Civil Aviation Organization (ICAO) Technical Instructions should be applied and for rail transport, the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID).

101. For further information, see subsection IV.F.3 of the general technical guidelines.

### 4. Labelling

102. All containers containing pesticide POPs should be clearly labelled with both a hazard warning label and a label which gives the details of the container and a serial number. The details should preferably include the contents of the container (exact counts of volume and weight), the type of waste, the trade name, the name of the active ingredient (including percentage), the name of the original manufacturer, the name of the site from which it originated so as to allow traceability, the date of repackaging and the name and telephone number of the responsible person during the repackaging operation. Each new package should bear identification labels as specified in the FAO training manual

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<sup>5</sup> See the International Maritime Dangerous Goods (IMDG) Code for details and other codes.

for inventory taking of obsolete pesticides (FAO, 2001). Additional and separate labels are required for materials classified as marine pollutants.

103. For further information, see subsection IV.F.4 of the general technical guidelines.

## **5. Transportation**

104. For information, see subsection IV.F.5 of the general technical guidelines.

## **6. Storage**

105. Although, generally, there are few specific regulations or guidelines for the storage of pesticide POPs, those regulations and guidelines developed for pesticide products should provide a minimum level of protection. In that regard, the FAO guidelines for pesticide storage and stock control (FAO, 1996) and for the design and structure of pesticide stores (*ibid.*) should be followed as a minimum. In addition, pesticide POPs should be stored as hazardous waste. Authorization from local authorities will be needed.

106. It is important to verify the authorization documents (for example, maximum quantities, permission if repackaging is allowed on a temporary storage site, maximum period of temporary storage, permission if substandard temporary storage conditions are allowed and so on).

107. For further information, see subsection IV.F.6 of the general technical guidelines.

## **G. Environmentally sound disposal**

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

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

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

109. For information, see subsection IV.G.2 of the general technical guidelines.

### **3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option**

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

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

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

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

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

## **I. Health and safety**

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

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

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

### **2. Lower-risk situations**

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

## **J. Emergency response**

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

## **K. Public participation**

117. Parties to the Basel or Stockholm Convention should have an open public participation process. For further information see section IV.K of the general technical guidelines. See also the FAO draft guidance document *The selection of waste management options for the disposal of obsolete pesticides and contaminated materials* (draft under preparation) (FAO, 2004).

## Annex I

### Synonyms and trade names for pesticide POPs

(See also Helsinki Commission, 2001; “The National Implementation Plan for Implementation of the Stockholm Convention in the Czech Republic”, Ministry of the Environment of the Czech Republic; PAN Pesticides Database – Chemicals; Ritter, EPA, Substance Registry System, STARS.)

Chemical	Some synonyms and trade names <sup>a</sup>
<b>Aldrin</b> (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>Aglyucon*, Agronex TA; Aldocit; Aldrec; Aldrex; Aldrex 30; Aldrex 30 E.C.; Aldrex 40; Aldrin cast solid; Aldrin mixture, dry (with 65 % or less aldrin); Aldrin mixture, dry (with more then 65 % aldrin); Aldrin mixture, liquid (with 65 % or less aldrin); Aldrin mixture, liquid (with 65 % 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; Alttox; Alvit 55; Compound 118; 4:5,8-Dimethanonaphthalene; 22DN*; Drinox; Eldrin; ENT-15949; Eruzin*; exo-Hexachlorodimethanonaphthalene; Hexachlorhexahydro-dimethanonaphthalene;</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; HDDN; 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 <sup>a</sup>
<b>Chlordane</b> (CAS no. 57-74-9)	<p>1-exo,2-endo,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7methanoindene;            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);            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</p>

Chemical	Some synonyms and trade names <sup>a</sup>
<b>Dieldrin</b> (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-,(1aalph;</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>Aldrin epoxide; Alvit; Alvit 55; Compound 497; D-31; Diel'drin*; Dieldrin; Dieldrin, dry weight;</p> <p>Dieldrin (hexachloroepoxyoctahydro-endo,exo-dimethanonaphthalene 85 % and related compounds 15 %); 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 <sup>a</sup>
<b>Endrin</b> (CAS no. 72-20-8)	<p>1a.alpha.,2.beta.,3.alpha.,6.alpha.;</p> <p>(1a.alpha.,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7a.alpha.)-2,7;3,6-dimethano-3,4,5,6,9,9-hexachlor-1a;</p> <p>(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-;</p> <p>(1R,4S,4aS,5S,7R,8R,8aR)-1,2,3,4,10,10-hexachloro-1,4,4a,5,6,7,8,8a-octahydro-6,7-epoxy-1,4:5,8-dime;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a- octahydro-1,4-endo-,8-endo-dimethano-naphthalen;</p> <p>3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth[2,3-b]oxirene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo, endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-5,8-endodimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo-1,4-endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo, endo-5,8-dimethanonaphthali;</p> <p>1,2,3,4,10,10-hexachloro-6,7-oxido-1,4-endo-5,8-endo-dimethano-1,4,4a,5,6,7,8-octahydronaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-1r,4s,4as,5s,6,7r,8r,8ar-octahydro-6,7-epoxy-1,4:5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-endo-endo-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalen;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-1,4-exo-5,8-dimethanonaph;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-exo-1,4-exo-5,8-dimethanonaphthalene;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-§1,4-endo-5,8-endo-dimethanonaphthali;</p> <p>1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-§octahydro-1,4-endo-endo-5,8-dimethanonaphthale;</p>

Chemical	Some synonyms and trade names <sup>a</sup>
	<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>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><b>Heptachlor</b> (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>Aahepta; Arbinex 30TN; Agronex Hepta; Agronex Hepta T 30; Agroceres; Basaklor; Bis(ethylamino)-chlortriazin; Chlor-bis(ethylamino)-triazin;</p> <p>Chlordiethyltriazindiamin; Drinox; Drinox H-34; E 3314; ENT-15152; Eptacloro;</p> <p>Geptachlor*; Geptazol*; Gesatop; Gold Crest H-60; GPKh; H-34; H-60; Hepta;</p> <p>Heptachlor; Heptachlorane; 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><b>Hexachlorobenzene</b> (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 <sup>a</sup>
<b>Mirex</b> (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.O'2,6.O'3,9.O'5,8)decane; Dodecachloro-decahydro-1,3-cyclo-dicyclobuta<cd,gh>pentalene; Dodecachlorooctahydro-1,3,4-metheno-1H-cyclobuta(cd)pentalen, 1,1a,2,2,3,3a,4,5,5,5a,5b,6-; Dodecachlorooctahydro-1,3,4-metheno-2H-cyclobuta<cd>pentalene; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'5,8)decane; Dodecachloropentacyclo<5.2.1.O'2,6.O'3,9.O'5,8>decane; Dodecachloropentacyclo(5.2.1.O'2,6.O'3,9.O'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
<b>Toxaphene</b> (CAS no. 8001-35-2)	2,2-dimethyl-3-methylenbornanachlorid; 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; Camphechlor; Chem-Phene; Chemphene M5055; Camphofene Huileux; Chlorinated Camphene; chloriertes 2,2-dimethyl-3-methylenbornan; Chloriertes Camphen; Chlorinated camphene, chlorinated camphene, 67%<conc chlorine<69%; technical; Chloro-Camphene; Clor Chem T-590; Compound 3956; Coopertox; Crestoxo; Cristoxo; Cristoxo 90; Delicia Fribal; Dimethyl-3-methylenbornanachlorid, 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 (67–69% chlorine); Toxon 63; Toxaphen 10; Toxaphen 50; Toxyphene; Vertac Agricide; Vertac 90 %

<sup>a</sup> The list of trade names is not intended to be exhaustive.

\* Russian trade names.

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