

STARTUP GUIDANCE

for the 9 new POPs (general
information, implications of listing,
information sources and alternatives)

December 2010



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LIST OF ACRONYMS

ABS	Acrylonitrile-butadiene-styrene
ACAP	Arctic Council's Arctic Contaminants Action Program
Alpha-HCH	Alpha hexachlorocyclohexane
BAT	Best Available Technique
BCF	Bioconcentration factor
BDE	Brominated diphenyl ether
BEP	Best Environmental Practices
Beta-HCH	Beta hexachlorocyclohexane
BFRs	Brominated flame retardants
BSEF	Bromine Science and Environmental Forum
CAS	Chemical Abstracts Service
COP	Conference of the Parties
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
HBB	Hexabromobiphenyl
HCH	Hexachlorocyclohexane
HCl	Hydrochloric acid
HELCOM Convention	Convention on the Protection of the Marine Environment of the Baltic Sea Area
HIPS	High Impact polystyrene
IARC	International Agency for Research on Cancer
LCD	Liquid Crystal Display
LRTAP	Long-Range Transboundary Air Pollution
NARAP	North American Regional Action Plan
NGO	Nongovernmental Organization
NICNAS	Australian National Industrial Chemicals Notification and Assessment Scheme
NIP	National Implementation Plan
OECD	Organisation for Economic Co-operation and Development
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic
PBBs	Polybromobiphenyls
PBT	Polybutylene terephthalate
PCBs	Polychlorinated biphenyls
PCP	Pentachlorophenol
PeCB	Pentachlorobenzene
PFOS	Perfluorooctane sulfonate
PFOSF	Perfluorooctane sulfonyl fluoride
PIC	Prior Informed Consent
POPRC	Persistent Organic Pollutants Review Committee
POPs	Persistent Organic Pollutants
PRTR	Pollutant Release and Transfer Registers
PVC	Polyvinylchloride
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UPE	Unsaturated polyesters
UK	United Kingdom
US	United States of America
US EPA	United States Environmental Protection Agency
RoHS	Restrictions on Certain Hazardous Substances in Electric and Electronic Equipment
SAICM	Strategic Approach to International Chemicals Management
SNURs	Significant New Use Rules
TCB	Trichlorobenzene
TeCB	Tetrachlorobenzene
WEEE	Waste from Electric and Electronic Equipment
WHO	World Health Organization



FOREWORD

1. The Stockholm Convention is a multilateral environmental agreement aimed at protecting human health and the environment from the risks posed by Persistent Organic Pollutants (POPs). Although initially developed for a list of twelve of these chemicals, the Convention established long-term objectives, including the possibility of listing additional POPs that would be subject to international obligations to reduce or eliminate production and use.
2. The Persistent Organic Pollutants Review Committee (POPRC), a scientific subsidiary body to the Convention, has completed an extensive review of the nine chemicals described in this document. The review process included the development of a risk profile and a risk management evaluation for each of the nine chemicals. These provide the supporting evidence of their POPs-like characteristics (persistence, bio-accumulation, potential for long-range environmental transport) and support the conclusion that global action is warranted. According to Paragraph 9 of Article 8 of the Stockholm Convention, based on the risk profiles and the risk management evaluations for these chemicals, the POPRC recommended that the Conference of Parties (COP) consider them for listing in Annexes A, B and/or C of the Convention. In May 2009, the Conference of the Parties decided to list these nine additional chemicals as POPs in the Annexes of the Convention.

Table 1. The 9 new POPs adopted at COP4

Chemicals	Annex	Specific exemptions/Acceptable purposes
Alpha hexachlorocyclohexane	A	Production: none / Use: none
Beta hexachlorocyclohexane	A	Production: none / Use: none
Chlordecone	A	Production: none / Use: none
Hexabromobiphenyl	A	Production: none / Use: none
Hexabromodiphenyl ether and heptabromodiphenyl ether	A	Production: none Use: recycling of articles that contain or may contain hexabromodiphenyl ether and heptabromodiphenyl ether, in accordance with provisions of Part IV of Annex A
Lindane	A	Production: none Use: human health pharmaceutical for control of head lice and scabies as second line treatment
Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	Production: none Use: recycling of articles that contain or may contain tetrabromodiphenyl ether and pentabromodiphenyl ether, in accordance with provisions of Part V of Annex A
Pentachlorobenzene	A and C	Production: none / Use: none
Perfluorooctane sulfonic acid its salts and perfluorooctane sulfonyl fluoride	B	Production: for the use below Use: several acceptable purposes and specific exemptions in accordance with Part III of Annex B

3. Once a decision to list a new POP under the Convention enters into force for a Party, it has to adhere to the obligations as outlined in the Convention and initiate the update of its National Implementation Plan (NIP) to address the additional POP. Parties can take advantage of their previous experience and lessons learned from their past NIP work for the initial 12 POPs. When updating its NIP, a Party needs to identify relevant objectives and goals, and develop action plans for the nine new POPs as appropriate. Existing publications and tools, such as guidelines developed by the United Nations Institute for Training and Research (UNITAR) to support the elaboration of NIPs, provide guidance that is useful for updating NIPs.
4. This document is a startup guidance for the nine new POPs. **Chapter 1** provides a summary of key information on each of the new POPs that has been extracted from the risk profiles and risk management evaluations. **Chapter 2** identifies issues that might arise from the listing of the new POPs and makes suggestions on how these can be addressed.
5. **Chapter 3** describes sources of information that can be used to develop a profile on the current situation of each new POP at the national level. It also provides guidance on how to address potential information gaps when the required information is not readily available. Given that intentional production and use of these nine POPs will eventually be banned or severely restricted, Parties are encouraged to find alternatives to substitute these chemicals. **Chapter 4** outlines an approach to assess available alternatives and uses examples to illustrate successful attempts to finding alternatives to POPs.

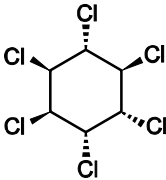
Chapter 1. INFORMATION ON THE NINE NEW POPs

6. This Chapter contains information on the nine new POPs contained in the risk profile and risk management evaluation documents developed by the POPs Review Committee. These documents can be consulted for more detailed information in the six official languages of the United Nations on the website of the Stockholm Convention: www.pops.int/poprc.

1. Alpha hexachlorocyclohexane

7. Alpha hexachlorocyclohexane is listed in Annex A of the Stockholm Convention without exemptions; hence Parties have to stop all production and use of this substance.

1.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	alpha hexachlorocyclohexane (alpha-HCH)
Synonyms/abbreviations:	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-trans-hexachloride, Hexachlorocyclohexane-Alpha
CAS number:	319-84-6
Structure:	
Molecular weight:	290.83
Molecular formula:	C ₆ H ₆ Cl ₆

8. Alpha hexachlorocyclohexane (alpha-HCH) is the only chiral isomer of the eight isomers of 1,2,3,4,5,6-HCH. It is the main secondary product (70% of all waste isomers) of the production process of gamma-HCH (lindane). Alpha-HCH is the predominant isomer found in ambient air and in ocean water.

9. The physical-chemical properties of alpha-HCH allow for long-range transport and “cold condensation”, an enrichment of the substance in cold climates compared to concentrations near sources. Alpha-HCH can volatilize due to its vapour pressure and low octanol-air partition coefficient from soil surfaces. The Henry’s law constant is relatively low and decreases with temperature.

10. Alpha-HCH is stable in light, at high temperatures, in hot water and in acids but it can be dechlorinated at high pH. The abiotic degradation of alpha-HCH is very slow especially at lower temperatures. Photolysis in aqueous media and air is considered insignificant in the degradation of alpha-HCH.

11. The log octanol-water partition coefficient (log K_{ow}) for alpha-HCH is 3.8, indicating that it has the potential to bioaccumulate. Bioconcentration factors estimated for some microorganisms and invertebrates are variable. For green algae the factor varies from about 200 to 2,700, and for fish it ranges from 1,100 to 2,800.

12. Many studies have reported alpha- and gamma-HCH throughout North America, the Arctic, Southern Asia, the Western Pacific, and Antarctica. HCH isomers are the most abundant and persistent of the organochlorine insecticide contaminants in the Arctic. The physico-chemical properties in combination with the stability of alpha-HCH allow it to undergo long range transport in the atmosphere. Its presence in the Arctic and in the Antarctic, where it has not been used or produced, confirms its long-range transport.

1.2 Production, export and trade information

13. Alpha-HCH by itself is not intentionally produced or commercialized. It is produced as the main constituent of technical HCH which was used as an organochlorine insecticide. Technical HCH consists of 70 % alpha-HCH, 7 % beta-HCH and 13 % gamma-HCH. Alpha-HCH was also a known by-product in the manufacture of gamma-HCH (lindane).

14. In the 1940s technical HCH was introduced on the market on a large scale, due to its universal insecticidal properties. The promising market opportunities worldwide grew in the search for an inexpensive alternative to DDT. However, due to the decreasing effectiveness mainly of the alpha-HCH and beta-HCH isomers in controlling insects, technical HCH was gradually replaced by lindane (> 99% gamma-HCH). Nevertheless, the manufacture of lindane



resulted in a huge amount of HCH residuals. Although the exact amounts of HCH residuals are not known, estimates based on global lindane production are in the range of 1.6 to 4.8 million tonnes worldwide. These values are far greater than the reported stockpiles of approximately 2,785 tonnes of technical HCH and 45 tonnes of unspecified HCH material in Africa and the Near East.

15. Since 2000 no significant use of alpha- and beta-HCH has been reported. The following countries stated that there is currently no production or use of alpha-HCH on their territory: Czech Republic, Germany, Mauritius, Mexico, Norway, Qatar, Republic of Lithuania, Turkey, Switzerland, and the United States of America. However, the manufacture of lindane is still taking place in a few countries.

1.3 Main uses and applications

16. Technical HCH usage steadily declined and now technical HCH is virtually no longer used. Historical data show that between 1948 and 1997, around 10 million tonnes of technical HCH were released into the environment; Europe used approximately 400,000 tonnes of technical HCH between 1970 and 1996. Global usage of technical HCH was dominated by 10 countries headed by China, which consumed almost half of the total global quantity. The other countries were (in order of decreasing usage): Former Soviet Union, India, France, Egypt, Japan, United States, East Germany, Spain and Mexico. Usage of technical HCH was banned in most western countries and Japan in the 1970s but continued in China and Russia until 1983 and 1990. In 1990, India also banned technical HCH in agriculture, but allowed continued use for public health purposes

17. Despite the prohibition of alpha-HCH use, there are indications that the use of stockpiles, limited use for public health purposes and/or illegal use are still ongoing.

1.4 Risk profile

18. Historically, alpha-HCH was released during the manufacture of technical HCH and its use as a pesticide. Alpha- and beta-HCH have the same global emission patterns which, however, differ in scale. The global usage of alpha-HCH (based on data on technical HCH) is considered 6 million tonnes, with 4.3 million tonnes emitted into the atmosphere. After the 1940s, emissions of alpha-HCH increased and peaked in the early 1970s. Due to the ban on the use of alpha-HCH in North America, in European countries and Japan, emissions decreased but reached a second peak in the 1980s when use increased in Asian countries. After the 1980s, figures dropped due to further prohibitions and restrictions in countries such as China.

19. Releases of alpha-HCH into the environment are also possible from hazardous waste sites, stockpiles and residues of lindane production, which are not always controlled or maintained safely. Contaminated sites (for example former production plants) may also contribute to the environmental burden of alpha-HCH.

20. Human exposure to alpha-HCH results mostly from ingestion of contaminated plants and animal products. Inhalation of ambient air and consumption of drinking water are minor sources of exposure. Infants may be exposed during fetal development and breastfeeding as a result of maternal uptake from the environment because of the bioavailability of alpha-HCH.

21. Alpha-HCH is present in the terrestrial and aquatic food chains; levels vary depending on species and location (usage and pollution levels). Alpha-HCH is in most cases the dominant isomer in fish. Alpha-HCH may bioaccumulate and biomagnify in biota and Arctic food webs. In general, studies from Arctic marine food webs show food web magnification factors, which represent the mean rate of increase per trophic level in the food chain, greater than 1, showing a potential for biomagnification.

22. Neurophysiological and neuropsychological disorders and gastrointestinal disturbances have been reported for workers exposed to technical HCH during pesticide or fertilizer formulation. Workers suffered from paraesthesia of the face and extremities, headache and giddiness, malaise, vomiting, tremors, apprehension, confusion, loss of sleep, impaired memory and loss of libido.

23. Inhalation of HCH (mixed isomers) may lead to irritation of the nose and throat. The observation of serious hepatic effects in animals (e.g., fatty degeneration and necrosis) suggests that the same might occur in workers following prolonged occupational exposure to HCH isomers.

24. No specific studies are available on the effects of alpha-HCH on humans. However, experimental studies show liver and kidney damage as well as a significant decrease in body weight gain in animals fed alpha-HCH. Animal experiments show that alpha-HCH affects the immune system, and immunosuppressive effects have been seen in humans exposed to technical HCH. New data suggest that alpha-HCH might disrupt endocrine processes and could have some genotoxic potential but the evidence for this is not conclusive. Epidemiological studies indicate an elevated incidence of breast cancer after exposure to alpha-HCH as well as hormonal disorders leading to infertility and abortions. A possible association with intrauterine growth retardation and aplastic anaemia has been postulated. The International Agency for Research on Cancer (IARC) has classified hexachlorocyclohexanes (including alpha-HCH) as a possible human carcinogen.

25. Based on the hazard profile and the exposure scenarios it was determined that alpha-HCH may adversely affect wildlife and human health in contaminated regions. In this respect, a study by the United States Environmental Protection Agency (US EPA) estimated, based on daily intake rates for the Arctic population, elevated cancer rates, though estimates are very conservative. The study considered that the liver is the target organ for all HCH-isomers, thereby leaving the risk of additive effects. Moreover the indigenous Arctic population as well as wildlife are exposed to a broad range of POPs including all HCH isomers and other pollutants leading to probably additive effects. While Arctic public health authorities believe the significant social, cultural and economic benefits of traditional foods outweigh the risks of contaminants such as HCH at present, this gives a good reason for the quick control and elimination of all HCH isomers from traditional foods.

1.5 Regulations at the international, regional and national levels

26. Alpha-HCH is a constituent of technical HCH, which is subject to different international regulations, including:

- The 1998 Aarhus Protocol on Persistent Organic Pollutants (POPs) under the Convention on Long-Range Transboundary Air Pollution lists technical HCH in Annex II of the protocol, which restricted its use to an intermediate in chemical manufacturing only.
- The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade included HCH (mixed isomers) as a chemical subjected to the PIC Procedure. HCH is listed in Annex III of the Convention.
- HCH isomers, including the alpha-isomer, are on the List of Chemicals for Priority Action under the OSPAR Commission for the Protection of the Marine Environment of the Northeast Atlantic.

27. At the regional level, prohibitions and/or regulations on the production, use and waste management of lindane exist in the European Union, where the production and use of technical HCH as an intermediate in chemical manufacturing was phased out by the end of 2007 at the latest (Regulation (EC) No 850/2004)¹. Canada, Mexico and the United States signed a North American Regional Action Plan (NARAP) on Lindane and other HCH isomers in 2006.

28. Current control measures for alpha- and beta-HCH in several countries include: prohibition of production, use, sale and import/export prohibition, prohibition of lindane production, requirements for inventories, clean-up of contaminated sites, disposal facilities for hazardous waste and management of obsolete stocks. Several countries reported that alpha- and beta-HCH are part of their national and international monitoring programmes. A thorough review of existing control measures, which have already been implemented in several countries including control measures for lindane, shows that risks from exposure of humans and the environment to alpha- and beta-HCH can be reduced significantly.

2. Beta hexachlorocyclohexane

29. Beta hexachlorocyclohexane is listed in Annex A of the Stockholm Convention without exemptions; hence production and use have to be eliminated by Parties.

2.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	beta hexachlorocyclohexane (beta-HCH)
Synonyms/abbreviations:	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
CAS number:	319-85-7
Structure:	
Molecular weight:	290.83
Molecular formula:	C ₆ H ₆ Cl ₆

¹ Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC; OJ L 158, 2004-04-30, p.1.



30. Beta hexachlorocyclohexane (Beta-HCH) is one of the five stable isomers of technical HCH, an organochlorine pesticide formerly used in agriculture. The modes of action of the HCH isomers differ quantitatively and qualitatively with regard to their biological activity in the central nervous system as the main target organ. Beta-HCH is mainly a depressant and the final effect of the mixed isomers depends on the composition.

31. Beta-HCH is more soluble in water and octanol compared to other organochlorine pesticides. Its chemical structure seems to confer the greatest physical and metabolic stability. The physical-chemical properties of beta-HCH allow for “cold condensation”, an enrichment of the substance in cold climates compared to concentrations near sources, on altitudinal and latitudinal scales. HCH isomers are resistant to abiotic processes like photolysis and hydrolysis (except at high pH), and microbial degradation is very slow.

32. The log octanol-water partition coefficient (log Kow) for beta-HCH is 3.78, indicating that it has the potential to bioaccumulate. A bioconcentration factor (BCF) equal to 1,460 was found for beta-HCH using zebra-fish under steady-state conditions compared. Different from other HCH, beta-HCH tends to bio-accumulate to higher concentrations in upper trophic level fishes, birds and mammals.

33. Beta-HCH is the most persistent isomer, with half-lives of 184 and 100 days on cropped and uncropped plots. It comprised 80-100% of the total HCH residues found in soil and vegetation on land surrounding an industrial landfill in Germany 10 years after the final HCH input. Beta-HCH is the predominant isomer in soils and animal tissues because its configuration favours storage in biological media and affords it greater resistance to hydrolysis and enzymatic degradation.

2.2 Production, export and trade information

34. Beta-HCH by itself is neither intentionally produced nor placed on the market. It is produced as constituent of technical HCH used as organochlorine insecticide or chemical intermediate to manufacture enriched HCH (lindane). Currently no production data on technical HCH have been reported, whereas manufacture of lindane still takes place.

35. In the 1940s technical HCH was introduced on a large scale on the market, due to its universal insecticidal properties. The promising market opportunities worldwide arose in the search for an inexpensive alternative to DDT. However, due to the decreasing effectiveness of the mainly of the alpha- and beta-HCH isomer in controlling insects, technical HCH was gradually replaced by lindane (> 99% gamma-HCH). Nevertheless, the manufacture of lindane has resulted in a huge amount of HCH residuals. Estimates vary from 1.9 to 4.8 million tonnes of HCH residuals based on global lindane production. These values are far beyond the stockpiles of approximately 2,785 tonnes of technical HCH and 45 tonnes of unspecified HCH material reported in 1999 in Africa and the Near East.

36. After almost forty years of extensive worldwide use, there has been a gradual replacement of technical HCH by lindane. No significant current uses of alpha- and beta-HCH have been reported after 2000. The following countries stated that there was currently no production or use of alpha- and beta-HCH: Czech Republic, Germany, Mauritius, Mexico, Norway, Qatar, Republic of Lithuania, Turkey, Switzerland, and the United States of America.

37. Alpha- and beta-HCH control measures currently implemented in several countries include: production, use, sale and import/export prohibition, prohibition of lindane production, establishment of inventories, clean-up of contaminated sites, access to disposal facilities for hazardous waste and management of obsolete stocks. Several countries reported that alpha- and beta-HCH are part of their national and international monitoring programmes.

2.3 Main uses and applications

38. Between 1948 and 1997, around 10 million tonnes of technical HCH were released into the environment. Europe used approximately 400,000 tonnes of technical HCH between 1970 and 1996. Global usage of technical HCH was dominated by 10 countries headed by China, which consumed almost half of the total global quantity. The other countries were (in order of decreasing usage): Former Soviet Union, India, France, Egypt, Japan, United States, East Germany, Spain and Mexico. Usage of technical HCH was banned in most western countries and Japan in the 1970s but continued in China and Russia until 1983 and 1990. In 1990, India also banned technical HCH for agricultural.

2.4 Risk profile

39. Historically, beta-HCH was released during the manufacture of technical HCH and its use as a pesticide. Global emissions of beta-HCH from 1945 to 2000 are 850,000 tonnes, of which 230,000 tonnes were emitted into the atmosphere over the same period. In 1980, the usage was around 36,000 tonnes, and calculated primary emissions were 9,800 tonnes. In 1990, figures dropped to 7,400 (usage) and 2,400 tonnes (emissions). In 2000, emissions of beta-HCH from soil residues were 66 tonnes in the absence of direct usage of technical HCH. Also, as a result of the ban on technical HCH in northern countries, global emissions of beta-HCH have undergone a “southward tilt”.

40. Due to extensive use over the past 50 years, persistence and long-range transport alpha- and beta-HCH can be detected in all environmental media including humans. Human exposure to alpha- and beta-HCH results mostly from ingestion of contaminated plants, animals and animal products. High exposure is expected in contaminated areas due to extensive use, former production, disposal sites and stockpiles.

41. Evidence exists of potential risks from dietary exposure to alpha- and beta-HCH isomers of communities in Alaska and others in the circumpolar Arctic region who depend on subsistence foods, such as caribou, seal and whale.
42. Children are more vulnerable against chemical substances than adults, however it is not known if they are more susceptible than adults to health effects from exposure to beta-HCH. Placental transfer of HCH in humans has been well documented and because beta-HCH is lipophilic and accumulates in adipose tissue and breast milk, this is another relevant exposure source for children. Beta-HCH concentrations in breast milk are highly exposure-dependent.
43. Workers exposed to technical HCH during pesticide or fertilizer formulation reported neurophysiological and neuropsychological disorders and gastrointestinal disturbances. Inhalation of HCH (mixed isomers) may lead to irritation of the nose and throat. The observation of serious hepatic effects in animals (e.g., fatty degeneration and necrosis) suggests that the same results could potentially occur in workers following prolonged occupational exposure.
44. The information on the toxicity of beta-HCH is mostly derived from experimental studies in animals. Compared to lindane, data available are limited, especially concerning human data because occupational exposure occurs mainly with technical-grade HCH and lindane.
45. Studies of short-, intermediate- and long-term exposure to beta-HCH in diet have reported liver and renal effects in animals. Beta-HCH has moderate toxicity for algae, invertebrates and fish.
46. US EPA's Integrated Risk Information System (IRIS) currently lists beta-HCH as a possible human carcinogen based on the incidence of hepatic nodules and hepatocellular carcinomas observed in male mice administered beta-HCH at a single dose level in the diet.

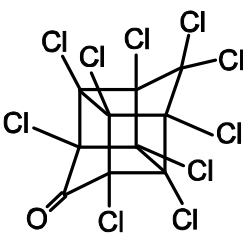
2.5 Regulations at the international, regional and national levels

47. See section 1.5 on regulation at the international, regional and national levels of alpha- and beta-HCH.

3. Chlordecone

48. Chlordecone is listed in Annex A of the Stockholm Convention without exemptions; hence all production and use have to be stopped by Party countries.

3.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	1,1a,3,3a,4,5,5,5a,5b,6-decachloro-octahydro-1,3,4-metheno-2H-cyclobuta-[cd]-pentalen-2-one
Synonyms/abbreviations:	Decachloropentacyclo-[5,2,1,0 ^{2,6} ,0 ^{3,9} ,0 ^{5,8}]-decan-4-one, Decachlorooctahydro-1,3,4-metheno-2H,5H-cyclobuta-[cd]-pentalen-2-one, Decachloroketone
Trade names:	GC-1189, Kepone, Merex, ENT 16391, Curlone.
CAS registry number:	143-50-0 CAS chemical name is 1,1a,3,3a,4,5,5,5a,5b,6-decachloro-octahydro-1,3,4-metheno-2H-cyclobuta[cd]pentalen-2-one
Structure:	
Molecular weight:	490.6
Molecular formula:	C ₁₀ Cl ₁₀ O

49. Chlordecone is a synthetic chlorinated organic compound which has mainly been used as an agricultural insecticide, miticide and fungicide. Chlordecone is chemically very similar to mirex, which is already listed under the Stockholm Convention. Chlordecone is not expected to hydrolyse or biodegrade in aerobic aquatic environments or in soil; however, there is some evidence of degradation under anaerobic condition. Direct photodegradation is not significant. Based on all available data chlordecone is considered to be highly persistent in the environment.



50. Because of the lipophilic nature of this compound (high octanol-water partition coefficient), chlordecone has a potential for both bioaccumulation and, with little or no metabolic depuration, also biomagnification in aquatic food chains.

3.2 Production, export and trade information

51. Chlordecone has been produced by reacting hexachlorocyclopentadiene and sulfur trioxide under heat and pressure in the presence of antimony pentachloride as a catalyst. The reaction product is hydrolyzed with aqueous alkali and neutralized with acid; chlordecone is recovered *via* centrifugation or filtration and hot air drying.

52. Chlordecone was first produced in 1951, its trade names are Kepone® and GC-1189. The technical grade, was available in the United States until 1976, it was also found to be present in grade mirex at concentrations up to 2.58 mg/kg (technical) and up to 0.25 mg/kg (bait formulations).

53. Between 1951 and 1975, approximately 1.6 million kg of chlordecone were produced in the United States, the production was discontinued in the US in 1976. However, a year later a French company was considering the establishment of production facilities in France, but no further information on this proposal is available.

54. Chlordecone was marketed in France as a formulation called Curlone by De Laguarique. From 1981 to 1993 it was used in Martinique and Guadeloupe following hurricane Allen in 1979 and David in 1980 which led to considerable pest infestations. Chlordecone for this formulation was synthesised in Brazil. The authorisation for Curlone was withdrawn by the French Ministry of Agriculture in 1990. Use was continued until September 1993. In Canada, no product containing chlordecone has been registered as a pest control product since 2000.

55. No current data are available regarding import volumes of chlordecone. By 1976, technical chlordecone was not exported any more from the United States and the compound was no longer produced there. Diluted technical grade chlordecone was exported to Europe, particularly Germany, in great quantities from 1951 to 1975 by the Allied Chemical Company where the diluted technical product was converted to an adduct, Kelevan, which is used for the same purposes. In the environment, Kelevan oxidizes to chlordecone. Approximately 90-99% of the total volume of chlordecone produced during this time was exported to Europe, Asia, Latin America, and Africa. There is no information indicating that Kelevan is being produced or used at present.

3.3 Main uses and applications

56. Chlordecone is no longer produced or used, but it has been used in various parts of the world for the control of a wide range of pests, specifically, it has been used extensively in the tropics for the control of the banana root borer. It has also been used as a fly larvicide, as a fungicide against apple scab and powdery mildew, to control the Colorado potato beetle, rust mite on non-bearing citrus, and potato and tobacco wireworm on gladioli and other plants. It is regarded as an effective insecticide against leaf-cutting insects, but less effective against sucking insects.

57. Chlordecone has also been used in household products such as ant and roach traps.

3.4 Risk profile

58. The effects of exposure to chlordecone have been observed in laboratory animals, in the environment and humans. Studies show that chlordecone is readily absorbed into the body and accumulates following prolonged exposure. The pesticide is both acutely and chronically toxic. Its adverse effects include neurotoxicity, immunotoxicity, reproductive, musculoskeletal and liver toxicity, and liver cancer. The International Agency for Research on Cancer has classified chlordecone as a possible human carcinogen (IARC group 2B). Chlordecone is absorbed through inhalation, oral, and dermal routes of exposure.

3.5 Regulations at the international, regional and national levels

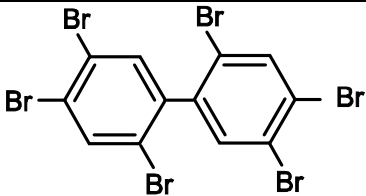
59. At the international level, Chlordecone is listed in Annex I of the Protocol on Persistent Organic Pollutants of the Convention on Long-Range Transboundary Air Pollution (LRTAP), which obliges Parties to phase out all production and uses of chlordecone. Chlordecone is also included in the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) as a substance of possible concern. Under the Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM Convention) it is also listed as a selected substance for immediate priority action (Recommendation 19/5, Attachment, Appendix 3) and is scheduled for elimination (Annex I, part 2). HELCOM aims at ceasing discharges, emissions and losses of hazardous substances by the year 2020.

60. At national level, Chlordecone is prohibited/restricted in Canada, the United States of America, Switzerland, Mauritius, Thailand and Mexico. Japan has included chlordecone in a list of 300 substances that need further risk evaluation.

4. Hexabromobiphenyl

61. Hexabromobiphenyl is listed in Annex A of the Stockholm Convention without exemptions; hence production and use have to be stopped by Parties.

4.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	Hexabromo-1,1'-biphenyl
Synonyms/abbreviations:	Hexabromobiphenyl, Biphenyl, hexabromo, 1,1'- biphenyl, hexabromo-, HBB
Trade names:	FireMaster(R) BP-6; FireMaster(R) FF-1
CAS registry number:	36355-01-8 (Common CAS number for HBB isomers and CAS number listed under the Stockholm Convention) 59536-65-1 Firemaster (R) BP-6 (EHC 192 (IPCS, 1997)) 67774-32-7 FireMaster(R) FF-1 (EHC 192 (IPCS, 1997))
Structure:	
Molecular weight:	627.58
Molecular formula:	C ₁₂ H ₄ Br ₆

62. Hexabromobiphenyl (HBB) belongs to a wider group of polybrominated biphenyls or “polybromobiphenyls” (PBBs) which are part of a group of brominated hydrocarbons produced and used as flame retardants in synthetic fibres and plastics. Technical PBBs contain several PBB compounds, isomers and congeners; hexabromobiphenyl is one of the main components of the technical product.

63. Polybrominated biphenyls are stable and persistent in the environment. The degradation of PBBs by purely abiotic chemical reactions, excluding photochemical reactions, is considered unlikely. While long-range transport of PBBs in the atmosphere has not been proven, their presence in Arctic seal samples indicates wide geographical distribution.

64. PBBs are lipophilic and able to bioconcentrate in the food chain; this is supported by results from wildlife studies, for example, fathead minnows (*Pimephales promelas*) caged in a river where levels of PBB remained consistently below 0.1 µg/l, contained more than 10,000 fold this concentration in their bodies after two weeks of exposure.

4.2 Production, export and trade information

65. PBBs were generally produced through the bromination of biphenyl. Commercial production began in 1970. Approximately 6 million kg of PBBs were produced in the United States from 1970 to 1976; HBB constituted about 5.4 million kg of this total. Production of PBBs stopped in the US in 1975, and any re-initiation of manufacture would require 90 days advance notification to the Environmental Protection Agency (EPA); the Agency would evaluate the intended use and associated activities, and could regulate the substance to prohibit or limit activities, as appropriate.

66. PBBs were produced in the United Kingdom, Germany and France. Available information suggests that, production and use of hexabromobiphenyl has ceased in most, if not all, countries. However, it is possible that hexabromobiphenyl is still being produced in some developing countries or in countries with economies in transition.

4.3 Main uses and applications

67. Hexabromobiphenyl was one of the principal PBB products used as a fire retardant in three main commercial products: acrylonitrile-butadiene-styrene (ABS) thermoplastics for construction of business machine housings and in industrial (e.g. motor housing), and electrical (e.g. radio and TV parts) products; as a fire retardant in coatings and lacquers, and in polyurethane foam for auto upholstery.

4.4 Risk profile

68. In addition to emissions during production or manufacturing of products, PBBs are released into the environment from the products that contain them as flame retardants. A considerable part of the PBBs produced will



probably reach the environment sooner or later because of their high stability. An additional concern is that polybrominated dibenzofurans can be formed during combustion of materials containing PBBs.

69. Few data are available on the effects of PBBs on organisms in the environment and no information is available on the effects of PBBs on ecosystems. These compounds are extremely persistent in living organisms and have been shown to produce chronic and acute toxic effects and cancer in experimental animals. The International Agency for Research on Cancer has classified hexabromobiphenyl as a possible human carcinogen; data also suggests that HBB is capable of disrupting the endocrine system.

4.5 Regulations at the international, regional and national levels

70. HBB has been identified as a persistent organic pollutant chemical under the Protocol on Persistent Organic Pollutants to the Convention on Long-range Transboundary Air Pollution. The provisions of the Protocol obligate Parties to phase out all production and use of hexabromobiphenyl.

71. HBB, together with other PBBs, is also included in the Rotterdam Convention on the Prior Informed Consent Procedure (PIC) for Certain Hazardous Chemicals and Pesticides in International Trade. OSPAR has listed HBB as a chemical of priority action since 1998.

72. At the European level HBB is listed in Annex I to EC Regulation No 850/2004 on persistent organic pollutants with a complete prohibition on production and use. Electric and electronic articles placed on the market in the European Union after July 2006 must not contain polybrominated biphenyls (EC Directive 2002/95/EC on Restrictions on Certain Hazardous Substances in Electric and Electronic Equipment (ROHS)). In addition Directive 2002/96/EC on Waste from Electric and Electronic Equipment (WEEE) requires plastic containing brominated flame retardants to be removed from any separately collected WEEE before recycling, other materials recovery or waste disposal processes takes place. The issue of hexabromobiphenyl in waste is addressed at the European level in Regulation 850/2004/EC. As amended by regulation 1195/2006/EC HBB in wastes has to be destroyed when concentrations are above 50 mg/kg.

73. At the national level, several countries have also limited the use of HBB and regulated its disposal. For example, Canada has prohibited the manufacture, use, sale, offer for sale, import and export (export is allowed just for the purpose of their destruction) of polybrominated biphenyls that have the molecular formula $C_{12}H_{(10-n)}Br_n$, in which "n" is greater than 2. This is established in CEPA 1999. In the US, HBB is subject to a TSCA Significant New Use Rule which would require notification to EPA prior to re-initiating manufacture or import for any use. In Australia, the manufacture, import and export of HBB, octabromobiphenyl and decabromobiphenyl are prohibited under the Industrial Chemicals Notification and Assessment Regulations 1990 unless the Director of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) has given written permission.

5. Hexabromodiphenyl ether and heptabromodiphenyl ether

74. Hexabromodiphenyl ether and heptabromodiphenyl ether are dominant components of the commercial mixture of octabromodiphenyl ether and originally proposed for listing as "commercial octabromodiphenyl ether". When the proposal for commercial octabromodiphenyl ether was assessed, the POPRC concluded that the best approach to address this mixture was to consider the brominated diphenyl ethers with six or seven bromines as these were the dominant component of the commercial mixture; thus hexabromodiphenyl ether and heptabromodiphenyl ether were recommended for listing and the Conference of the Parties decided to list those substances in Annex A of the Convention. Hence production and use have to be eliminated by Parties. However, there are specific use exemptions for the recycling of articles that contain these substances. Parties that want to continue recycling of articles that contain those substances and the use and final disposal of articles manufactured from recycled materials that contain those substances in accordance with part IV of Annex A need to notify the Secretariat. The Secretariat keeps a register for identifying Parties that have specific exemptions that is available to the public

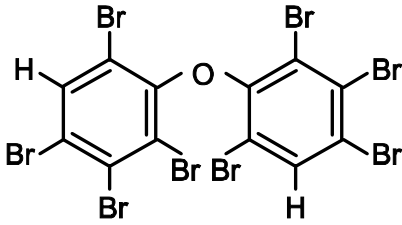
75. Under the Stockholm Convention, "hexabromodiphenyl ether and heptabromodiphenyl ether" means 2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153, CAS No: 68631-49-2), 2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154, CAS No: 207122-15-4), 2,2',3,3',4,5',6-heptabromodiphenyl ether (BDE-175, CAS No: 446255-22-7), 2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183, CAS No: 207122-16-5) and other hexa- and heptabromodiphenyl ethers present in commercial octabromodiphenyl ether. In this chapter, the chemicals are referred to as c-OctaBDE.

5.1 Chemical and physical properties

76. The term "c-OctaBDE" designates a commercial mixture containing polybrominated diphenyl ethers (PBDEs) with varying degrees of bromination, typically consisting of penta- to decabromodiphenyl ether isomers and containing approximately 79% (by weight) organically bound bromine. This bromine content corresponds to a true OctaBDE molecule and so the commercial products were often called "OctaBDE" even though the product contains a range of PBDEs. These synthetic brominated compounds have mainly been used as flame retardants, and contain significant amounts of other component groups with persistent organic pollutant characteristics.

77. The commercially supplied octaBDE is a complex mixture consisting typically of penta, hexa, hepta, octa, nona and decabromodiphenyl ether isomers. The composition of older products or products from non European Union (EU)

countries may be different.

Chemical identification and physical properties	
Chemical name and CAS registry number:	Hexabromodiphenyl ether and heptabromodiphenyl ether” means 2,2',4,4',5,5'-hexabromodiphenyl ether (BDE-153, CAS No: 68631-49-2), 2,2',4,4',5,6'-hexabromodiphenyl ether (BDE-154, CAS No: 207122-15-4), 2,2',3,3',4,5',6-heptabromodiphenyl ether (BDE-175, CAS No: 446255-22-7), 2,2',3,4,4',5',6-heptabromodiphenyl ether (BDE-183, CAS No: 207122-16-5) and other hexa- and heptabromodiphenyl ethers present in commercial octabromodiphenyl ether
Synonyms/abbreviations:	Octabromobiphenyl oxide, octabromodiphenyl oxide, octabromo phenoxybenzene and benzene, 1,1' oxybis-, octabromo derivative
Structure:	
Molecular weight:	801.38
Molecular formula:	C ₁₂ H ₂ Br ₈ O
Solubility in water (mg/litre):	0.0005
Vapour pressure:	6.59 x 10 ⁻⁶

78. C-OctaBDE has been found to photodegrade rapidly in a mixture of organic solvents, but the environmental significance of such a finding is uncertain because it is predicted to adsorb strongly onto sediment and soil, which means that only a fraction of this PBDE will be exposed to sunlight. No information is available on the hydrolysis of octaBDE, but it is not expected to be an important process for it in the environment.

79. C-OctaBDE is not readily biodegradable in standard tests and is not expected to degrade rapidly under anaerobic conditions. Nevertheless, other more highly brominated congeners have been found to degrade anaerobically in sewage sludge, although at a very slow rate. The evidence seems to indicate that there is little significant biotic or abiotic degradation of octaBDE. Although octaBDE congener would be expected to be bioaccumulative, the experimental result indicates that octaBDE does not bioconcentrate (BCF<9.5), probably due to its large size, which may preclude the crossing of cell walls in organisms.

5.2 Production, export and trade information

80. The information provided by the bromide industry indicates that the commercial product has been produced in the Netherlands, France, US, Japan, UK and Israel, but since 2004, it is no longer produced in the EU, US and the Pacific Rim and there is no information that indicates it is being produced in developing countries. Assuming that c-OctaBDE is not longer produced, the releases to the environment must be associated to historical processes, as well as to releases during the service life of articles containing the commercial mixtures and at the end of article service life during disposal operations.

81. There are no accurate values on the amount of c-Octa and/or the individual homologues in articles in service and disposed at the world-wide level, but considering the estimated figure of 6,000 tonnes/year the total amount should be expected in the 10⁵ – 10⁶ tonnes range. According to the Bromine Science and Environmental Forum (BSEF), OctaBDE was commercialized sometime in the mid 70's. By the early 2000's global production was <4,000 tonnes/year and by the time production ceased, demand was <500 tonnes. While thus, assuming 30 years of production at 6,000 tonnes per year gives 180,000 tonnes, a figure within the proposed range.

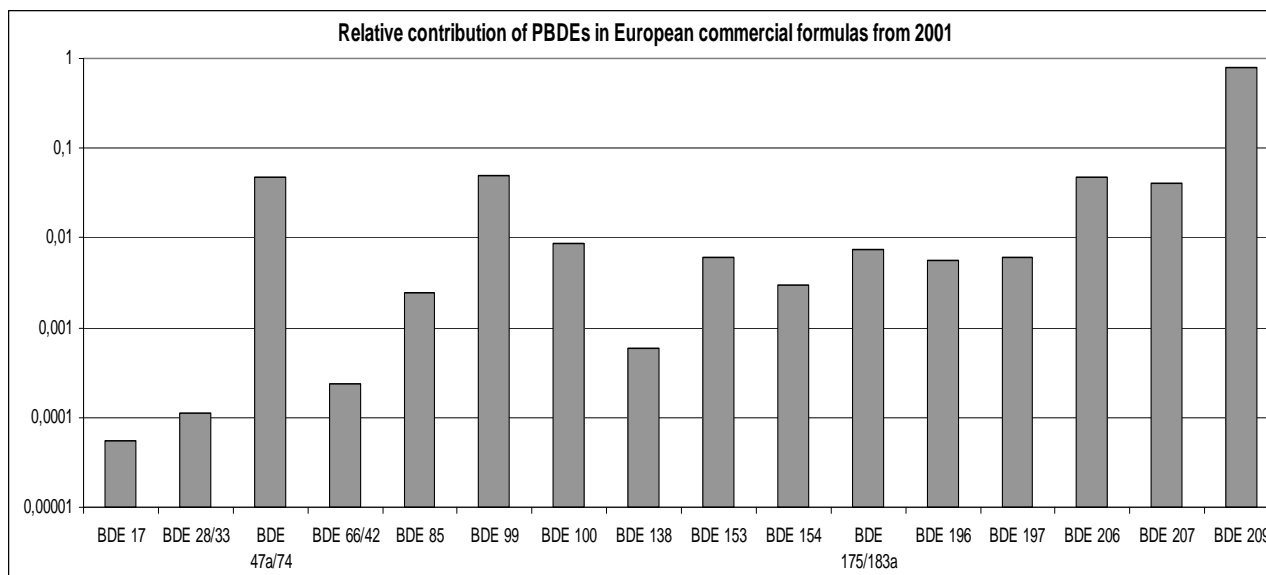
5.3 Main uses and applications

82. The polybrominated diphenyl ethers are used in general as flame retardants of the additive type, they are physically combined with the material being treated rather than chemically combined. This means that there is the possibility that the flame retardant may diffuse out of the treated material to some extent. In Europe, these substances



are primarily used in acrylonitrile-butadiene-styrene (ABS) polymers. Around 95% of the total octabromodiphenyl ether supplied in the EU is used in ABS. Other minor uses include high impact polystyrene (HIPS), polybutylene terephthalate (PBT) and polyamide polymers. In some applications, the flame retardant is compounded with the polymer to produce pellets (masterbatch) with slightly higher loadings of flame retardant.

83. Flame retarded polymer products are typically used for housings of office equipment and business machines. Other uses include nylon and low density polyethylene, polycarbonate, phenol-formaldehyde resins and unsaturated polyesters and in adhesives and coatings. The next figure shows the estimated relative contribution of different BDE congeners in products in the European market in 2001 (Note the logarithmic scale).



5.4 Risk profile

84. The possible formation of brominated dibenzo-p-dioxins and dibenzofurans during combustion or other high temperature processes involving articles containing c-OctaBDE is a cause of concern. The c-OctaBDE and relatives are subject to long range environmental transport and in many studies they have found to be in the atmosphere absorbed to particles in different amounts which vary from picograms to micrograms. Their presence in water has been demonstrated mainly in surface waters, although in low concentrations. C-OctaBDE has the ability to cumulate in sediments, where they are usually uptake by worms. Some components of c-OctaBDE enter into the food chain and bioaccumulate in fatty tissues of top predators, including humans.

85. The available ecotoxicity data for c-OctaBDE show little or no effect on aquatic, sediment and soil organisms. However, the EU Risk Assessment Report identifies a risk of secondary poisoning in other species (via ingestion of earthworms) for the hexabromodiphenyl ether component in the c-OctaBDE product. OctaBDE has been found in surface and subsurface soils, even in zones where it has not been used directly, considered as 'undisturbed', it has also been found in waste effluent and biosolids, resulting mainly from wastewater treatment plants.

86. Within the EU, c-OctaBDE has been classified as "Toxic", due to its effects on human health, with the risk phrases "may cause harm to unborn child", and "possible risk of impaired fertility". The presence of lower brominated diphenyl ethers in the c-OctaBDE products is of concern also from the human health point of view as they are likely to have a higher potential to cause adverse effects.

87. Unfortunately, wild populations are co-exposed to a mixture of PBDEs as well as to other related brominated and chlorinated persistent pollutants. With the current level of knowledge epidemiological investigations can just present associations but no cause-effect relationships between the exposure/accumulation of the components of the c-OctaBDE mixtures and potential adverse effects observed in wildlife.

88. A similar situation is observed regarding human health data, and no studies offering conclusive evidence on the hazards of hexa to nonaBDE for humans at environmentally relevant exposure levels have been found.

5.5 Regulations at the international, regional and national levels

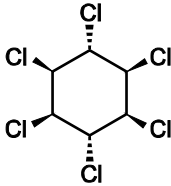
89. OctaBDE is included in the list of selected substances for the OSPAR lists (no 236). Under the reviewed list, it is put under section C – substances put on hold because they are not produced and/or used in the OSPAR catchment or are used in sufficiently contained systems making a threat to the marine environment unlikely.

90. C-OctaBDE is being considered for inclusion in the United Nations Economic Commission for Europe's (UNECE's) Convention on Long-range Transboundary Air Pollution (LRTAP) and its Protocol on Persistent Organic Pollutants (POPs).

6. Lindane

91. Lindane is listed in Annex A of the Stockholm Convention with no specific exemption for production; there is a specific exemption for use as human health pharmaceutical for control of head lice and scabies as second line treatment, which allows existing stocks to be used for such purpose following World Health Organization (WHO) guidelines. Parties that want to continue using lindane for this purpose need to notify the Secretariat. The Secretariat keeps a register for identifying Parties that have specific exemptions that is available to the public.

6.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	gamma, 1,2,3,4,5,6-hexachlorocyclohexane
Synonyms/abbreviations:	gamma benzene hexachloride; gamma-BHC
Trade names:	Agrocide, Aparasin, Arbitex, BBH, Ben-hex, Bentox, Celanex, Chloresene, Dvoran, Dol, Entomoxan, Exagamma, Forlin, Gallogama, Gamaphex, Gammalin, Gammex, Gammexane, Hexa, Hexachloran, Hexaverm, Hexicide, Isotos, Kwell, Lendine, Lentox, Linafor, Lindafor, Lindagam, Lindatox, Lintox, Lorexane, Nexit, Noco-chloran, Novigam, Omnitox, Quellada, Silvanol, Tri-6, Vitron.
CAS registry number:	58-89-9
Structure	
Molecular weight:	564.7
Molecular formula:	C ₆ H ₆ Cl ₆

92. Lindane is the common name for the gamma isomer of hexachlorocyclohexane, which is used as an insecticide. It is a white crystalline solid, stable in light, heat, air, carbon dioxide and strong acids, which is purified from the technical grade mixture of hexachlorocyclohexane.

93. Lindane is a volatile compound which can be found in remote regions where it is not used, such as the Arctic, and therefore has potential of long-range transport.

94. The half-life of lindane varies from 2.3 to 13 days in air, 30 to 300 days in water, 50 days in sediments and two years in soil. It is stable to light, high temperatures and acid but it can be hydrolysed at high pH. It degrades very slowly by microbial action and is more water-soluble and volatile than other chlorinated organic chemicals. This is why it is found in all environmental media (water/snow, air, soil/sediments).

95. While lindane has the potential to bioaccumulate in the food chain because of its high lipid solubility, biotransformation and elimination are relatively rapid. It has been found in seabirds, fish and mammals in the Arctic and in other regions of the world.

6.2 Production, export and trade information

96. Technical-HCH is manufactured through the photochlorination of benzene, which yields a mixture of five main isomers. This mixture is then subject to fractional crystallization and concentration to produce 99% pure lindane. Its production is inefficient with only a 10-15% yield; this means that for each tonne of lindane (gamma isomer) obtained, 6-10 tonnes of other isomers are also produced. There have been variations in production methods for HCH and lindane, as well as for HCH isomers' destruction or re-use. However, due to higher costs, these are not profitable. The lindane industry indicates that modern production technology can process the unwanted isomers into TCB



(trichlorobenzene) and HCl (hydrochloric acid) thereby reducing the production of wastes and minimizing any environmental contamination from these isomers.

97. Historical production of technical HCH and lindane from 1950 or earlier occurred in many European countries: Albania, Czech Republic, Spain, France, Germany, United Kingdom, Italy, Romania, Bulgaria, Austria, Hungary, Slovakia, and Poland. It has also been produced in other countries including Argentina, Azerbaijan, Brazil, China, Ghana, India, Japan, Russia, Turkey and the United States. It appears that in the last ten years the production of lindane has rapidly decreased leaving only a small number of producing countries; some sources indicate that Russia, Romania and China have stopped producing lindane. It seems that India is the only country still producing lindane. Global production between 1990 and 1995 was around 3,222 tonnes per year.

98. In 1998, the Food and Agriculture Organization Inventory of Obsolete, Unwanted and/or Banned Pesticides found a total of 2,785 tonnes of technical-grade HCH, 304 tonnes of lindane, and 45 tonnes of unspecified HCH material scattered in dumpsites in Africa and the Near East. According to the information from the Arctic Council's Arctic Contaminants Action Program (ACAP) project on obsolete pesticides, possibly up to 1,000 tonnes of obsolete stockpiles of technical HCH and lindane still exist in the Russian Federation after the ban of production in the beginning of the 1990s.

6.3 Main uses and applications

99. Lindane has been used as a broad-spectrum insecticide, which acts for both agricultural and non-agricultural purposes. Lindane has been used for seed and soil treatment, foliar applications, tree and wood treatment and against ectoparasites in both veterinary and human applications.

100. It is estimated that global lindane usage from 1950 to 2000 for agricultural, livestock, forestry, human health and other purposes amounts to around 600,000 tonnes. The next table shows agricultural lindane usage in different continents between 1950 and 2000.

Continent	Usage between 1950-2000 (tonnes)
Europe	287,160
Asia	73,200
America	63,570
Africa	28,540
Oceania	1,032
Total	435,500

101. Lindane is registered for use in 17 countries (CEC 2006). India produces and uses lindane for the control of mites in sugarcane at 200 tonnes per year, in the United States the only registered agricultural use for lindane is for seed treatment.

102. In the European Community, all uses of HCH including lindane have been banned. Currently, in the United States and Canada, lindane is allowed for public health purposes as a lice and scabies treatment on humans.

6.4 Risk profile

103. Lindane can be found in all environmental compartments. Levels in air, water, soil, sediment, aquatic and terrestrial organisms and food have been measured worldwide. Detectable levels in human blood, human adipose tissue and human breast milk indicate that widespread human exposure occurs.

104. The accumulation of HCH isomers, including lindane, in colder climates of the world is of special concern. High concentrations of HCH isomers, including lindane, have been measured in the Beaufort Sea and northern Canadian archipelago. Lindane can enter the food chain and accumulate in fatty animal tissue constituting an important exposure pathway for Arctic or Antarctic animals as well as for humans who rely on these animals for their subsistence diets. Lindane residues can also be found in milk and meat from livestock that has been treated for ectoparasites. Food is the most common human exposure pathway to lindane; a correlation between food intake, especially fish, meat and dairy products, and marine mammals, and lindane concentrations in body fat and human milk has been shown.

105. Exposure of children to lindane is a particular concern since there are several exposure routes and by the ongoing presence of HCH isomers, including lindane, in human tissues and breast milk. Gamma-HCH has been found in human maternal adipose tissue, maternal blood, umbilical cord blood and breast milk. Lindane has also been found to pass through the placental barrier. Medical use of products to treat head lice and scabies applied to children is also of concern, although most adverse effects observed have been the result of misuse. An additional exposure route for children exists in regions where lindane is applied directly to milk and meat producing livestock for pest control. On a body weight basis, children consume more milk per unit body weight than adults, and thus may be exposed to

significant concentrations of lindane residues through drinking milk. Another exposure to possibly significant amounts of lindane might occur through household dust in certain conditions.

106. Lindane is the most acutely toxic HCH isomer. It affects the central nervous and endocrine systems. In humans, effects from acute exposure at high concentrations to lindane may range from mild skin irritation to dizziness, headaches, diarrhea, nausea, vomiting, and even convulsions and death. Respiratory, cardiovascular, hematological, hepatic and endocrine effects have also been reported for humans, following acute or chronic lindane inhalation. Hematological alterations like leukopenia, leukocytosis, granulocytopenia, granulocytosis, eosinophilia, monocytosis, and thrombocytopenia, have been reported, following chronic human occupational exposure to gamma-HCH at production facilities.

107. The most commonly reported acute effects associated with ingestion of gamma-HCH are neurological; seizures and convulsions have been observed in individuals who have accidentally or intentionally ingested lindane in insecticide pellets, liquid scabicide or contaminated food.

108. Numerous studies have demonstrated hepatotoxic, genotoxic, reproductive, developmental and immunotoxic effects of lindane in laboratory animals. The International Agency for Research on Cancer (IARC) has classified lindane as possibly carcinogenic to humans.

109. Lindane is reported to be highly toxic to some fish and other aquatic species.

6.5 Regulations at the international, regional and national levels

110. At the international level, lindane is listed as:

- A “substance scheduled for restrictions on use” in Annex II of the 1998 Protocol on Persistent Organic Pollutants of the Convention on Long-Range Transboundary Air Pollution. It was restricted to the following uses: 1. Seed treatment. 2. Soil applications directly followed by incorporation into the topsoil surface layer 3. Professional remedial and industrial treatment of lumber, timber and logs. 4. Public health and veterinary topical insecticide. 5. Non-aerial application to tree seedlings, small-scale lawn use, and indoor and outdoor use for nursery stock and ornamentals. 6. Indoor industrial and residential applications.²
- A chemicals subject to the prior informed consent procedure under Annex III of the Rotterdam Convention on the Prior Informed Consent Procedure.³
- A Chemical for Priority Action (updated 2005) under the OSPAR Commission for the Protection of the Marine Environment of the Northeast Atlantic (listing of HCH isomers, including lindane).⁴

111. At regional level, the Great Lakes Binational Toxics Strategy between the United States and Canada includes HCH (including lindane) as a Level II substance.⁵ A North American Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane Isomers is being implemented under the Sound Management of Chemicals programme, which is an ongoing initiative to reduce the risks of toxic substances to human health and the environment in North America.

112. Lindane is also listed under the European Water Framework Directive. This Directive requires all inland and coastal water bodies to reach at least “good status” by 2015. Lindane is one of the listed priority hazardous substances for which quality standards and emission controls will be set at EU level to end all emissions within 20 years.

113. Lindane is banned for use in 52 countries, restricted or severely restricted in 32 countries, not registered in 10 countries, and registered in 17 countries (CEC 2006).

7. Tetrabromodiphenyl ether and pentabromodiphenyl ether

114. Tetrabromodiphenyl ether and pentabromodiphenyl ether are dominant components of the commercial mixture of pentabromodiphenyl ether and originally proposed for listing as “commercial pentabromodiphenyl ether”. When the proposal for commercial pentabromodiphenyl ether was assessed, the POPRC concluded that the best approach to address this mixture was to consider the brominated diphenyl ethers with four or five bromines as these were the dominant component of the commercial mixture; thus tetrabromodiphenyl ether and pentabromodiphenyl ether were recommended for listing and the Conference of the Parties decided to list those substances in Annex A of the Convention. Hence production and use have to be eliminated by Parties. However, there are specific use exemptions for the recycling of articles that contain these substances. Parties that want to continue recycling of articles that contain c-PentaBDE and the use and final disposal of articles manufactured from recycled materials that contain c-OctaBDE in accordance with part V of Annex A need to notify the Secretariat. The Secretariat keeps a register for identifying Parties that have specific exemptions that is available to the public.

²Convention on Long-range Transboundary Air Pollution <http://www.unece.org/env/lrtap/>

³Rotterdam Convention <http://www.pic.int>.

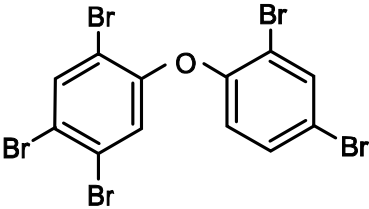
⁴OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic. <http://www.ospar.org/>

⁵Great Lakes Binational Toxics Strategy <http://www.epa.gov/glnpo/gls/index.html>



115. Under the Stockholm Convention, “tetrabromodiphenyl ether and pentabromodiphenyl ether” means 2,2',4,4'-tetrabromodiphenyl ether (BDE-47, CAS No: 5436-43-1) and 2,2',4,4',5-pentabromodiphenyl ether (BDE-99, CAS No: 60348-60-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether. The acronym PBDE is used for the generic term polybromodiphenyl ether, covering all congeners of the family of brominated diphenyl ethers. It is sometimes abbreviated to BDE. In this chapter, the chemicals are referred to as c-PentaBDE.

7.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name and CAS registry number:	“Tetrabromodiphenyl ether and pentabromodiphenyl ether” means 2,2',4,4'-tetrabromodiphenyl ether (BDE-47, CAS No: 5436-43-1) 2,2',4,4',5-pentabromodiphenyl ether (BDE-99, CAS No: 60348-60-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether.
Synonyms/abbreviations:	Pentabromodiphenyl ether (PeBDPE and PentaBDPE), Benzene, 1,1'-oxybis-, pentabromo derivative, Pentabromophenoxybenzene, Pentabromobi(s)phenyl ether; biphenyl ether, pentabromo derivative = PeBBE, Pentabromobi(s)phenyl oxide = PeBBO, Pentabromodiphenyl oxide = PeBDPO = PentaBDPO
Trade names:	Bromkal 70, Bromkal 70 DE, Bromkal 70 5DE, Bromkal G1, Great Lakes DE 71, Great Lakes DE-60 F (85% PeBDE), FR 1205/1215, Pentabromprop, Saytex 115, Tardex 50.
Structure:	
Molecular weight:	564.7
Molecular formula:	C ₁₂ H ₅ Br ₅ O

116. PentaBDE is persistent in the environment. Half-lives for BDE-99 and BDE-47 have been estimated at 600 days (aerobic sediment) and 150 days (water and soil) for both congeners.

117. Several studies have shown the potential of PentaBDE for bioaccumulation and biomagnifications, finding an increase of concentrations in biota with increasing trophic level in pelagic and Arctic food webs. High levels in top predators are usually an indication on the potential of a compound to bioaccumulate in the top predator food chain. In the Arctic, c-PentaBDE is detected in high levels in top predatory birds and mammals (such as polar bears, ringed seals and beluga whales).

118. Pentabromodiphenyl ether has also long-range transport potential as indicated the detected levels in the Arctic atmosphere, biota and environment. There are several studies showing the occurrence of PentaBDE in remote areas in Europe as well. PentaBDE (as all BDEs) has been detected in Canadian and Russian Arctic air at concentrations. The main route of transportations is the atmosphere.

7.2 Production, export and trade information

119. C-PentaBDE has been produced in the EU, Israel, the United States of America and Japan. In 2001 alone, almost 70,000 tonnes of PBDEs were produced globally, almost half of which was used in products sold in the US and Canada. Before the phase-out in the US, the majority of c-PentaBDE formulation produced globally was used in North America (>97 %). At the end of 2004, approximately 7.5% of the more than 2.1 billion pounds of flexible polyurethane foam produced each year in the US contained the c-PentaBDE formulation. However, since 2001 actions to regulate or voluntarily phase-out c-PentaBDE have been conducted in several countries.

120. Production in the EU ceased in the former 15 member states in 1997 and use was banned in 2004 and 2006 for electrical and electronic appliances. A major bromine producer in Israel, Israel Chemicals and Industrial Products (formerly the Dead Sea Bromine Group) declares that its products do not contain PentaBDE and the sole US manufacturer voluntarily ceased production in 2004. Although a patent on production of c-PentaBDE was taken out in China as recently as 1999 for a PBDE mixture that differs from the traditional penta-mix, the substance is being phased

out in that country. Remaining production in China was estimated as less than 100 tonnes/year; however, China expressed its intention to cease production in 2007 and ban its use.

121. Today there is no production in Japan. The use of c-PentaBDE was voluntarily withdrawn from the Japanese market in 1990. There are indications on a phase-out of c-PentaBDE in manufacture of new electrical and electronic products in the Asian region, although uses there were always subsidiary to the major uses in polyurethane foams. The extent of this is uncertain.

122. C-PentaBDE is mainly imported and exported for incorporation into finished articles. Polyurethane foam scrap generated by cutting process of blocks during their manufacture can be also commercialized. The EU exports about 40,000 tonnes of scrap foam per year to the US for recycling into carpet underlay (rebond). In 2000, Canada imported approximately 1,300 tonnes of c-PentaBDE as finished articles. Based on quantities reported, c-PentaBDE was the PBDE imported in greatest volume, followed by the commercial decabromodiphenyl ether product.

123. In Australia in 2004, the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) advised that all importers were phasing out imports of PentaBDE by the end of 2005, and this was reconfirmed by the major importers in mid-2005.

7.3 Main uses and applications

124. C-PentaBDE is used or has been used in the following sectors:

- Electrical and electronic appliances (EE appliances) – computers, home electronics, office equipment, household appliances and other items containing printed circuit laminates, plastic outer casings and internal plastic parts such as small run components with rigid polyurethane elastomer instrument casings.
- Traffic and transport – cars, trains, aircraft and ships containing textile and plastic interiors and electrical components.
- Building materials – foam fillers, insulation boards, foam insulation, pipes, wall and floor panels, plastic sheeting, resins etc.
- Furniture – upholstered furniture, furniture covers, mattresses, flexible foam components.
- Textiles – curtains, carpets, foam sheeting under carpets, tents, tarpaulins, work clothes and protective clothing.
- Packaging – polyurethane foam based packaging materials.

125. The most common use, accounting for 95-98% of c-PentaBDE since 1999, has been in polyurethane foam. This foam may contain between 10 and 18% of the c-PentaBDE formulation. Polyurethane foam is mainly used for furniture and upholstery in domestic furnishing, automotive and aviation industry. Other uses are in rigid polyurethane elastomers in instrument casings, in epoxy resins and phenolic resins in electrical and electronic appliances, and construction materials. For some years now, the more highly brominated Deca-BDE has been preferred in these applications.

126. Based on the last information on total market demand of c-PentaBDE presented at the Bromine Science and Environmental Forum (BSEF), the estimated cumulative use of c-PentaBDE since 1970 was 100,000 tonnes. The total market demand decreased during the later years of this period, for example from 8,500 tonnes in 1999 to 7,500 tonnes in 2001 (BSEF, 2001). The following table presents c-PentaBDE volume estimates:

Total market demand by region in tonnes:

	America	Europe	Asia	Rest of the world	Total
1999	8,290	210	-	-	8,500
2001	7,100	150	150	100	7,500

127. These consumption figures need to be seen in the context of the global demand for polybrominated flame retardants of all types, which vastly outweighs the demand for c-PentaBDE. Thus, world totals of PBDE were 204,325 (1999), 203,740 (2001), 237,727 (2002) and 223, 482 (2003) tonnes.

128. According to a market analyst consulting company, the global demand for flame retardants is expected to grow at 4.4% per year, reaching 2.1 million metric tonnes in 2009, valued at \$4.3 billion. Growth will largely be driven by gains in developing countries in Asia (China, in particular), Latin America and Eastern Europe. Strong increases are forecast for most of the flame retardants. After a severe falloff in demand in 2001, electrical and electronic applications will continue to recover. Demand growth for flame retardants will be strongest in such applications. Construction markets will be the second fastest growing globally, but in China second place will be held by motor vehicles, followed by textiles, both of which industries are growing rapidly in that country.



129. Usage in the EU (former 15 member states) has been declining during the second half of the 1990s and is estimated to have been 300 tonnes in 2000 (used solely for polyurethane production). The use of PentaBDE was banned in the 25 EU member states in 2004. Use in electrical and electronic appliances ceased in 2006.

130. A ban on some brominated flame retardants in Western Europe is not expected to spread substantially to other regions, but it will drive the development of alternatives in electrical and electronic equipment for sale on the world market.

7.4 Risk profile

131. PentaBDE is released into the environment during the manufacturing process, in the manufacture of products, during their use and after they have been discarded as waste. Most of the PentaBDE is released as diffuse pollution during and after the service life of articles incorporating c-PentaBDE and as small-scale point source pollution from the waste management chain of the end products. C-PentaBDE can volatilize from the surface of articles during their life cycle. It can be estimated that 585-1,053 tonnes of PentaBDE enter the environment in this way each year.

132. PentaBDE has spread widely in the global environment. A large quantity of monitoring data exist with detected levels in marine and terrestrial birds, sea and terrestrial mammals, sediments, soil, seafood and fish. In the Arctic, together with other pollutants of concern, PentaBDE is detected in high levels in top predatory birds and mammals showing that the Arctic food webs are seriously affected. Most trend analysis show an increase in concentrations of PBDEs in the environment and in humans from the beginning of the 1970s, with a peak around the mid-1990s and a stabilisation or subsequent levelling off in Europe, but with a continuous increase in the Arctic.

133. The main routes for human exposure are food, and exposure to dust in indoor air at home and workplaces due to levels in products like furniture and electronic devices. Fish and agriculture products are the main food sources of PentaBDE for humans, and mother's milk for the nursing child.

134. Evidence suggests that the major congeners of the c-PentaBDE formulation, BDE-47 and BDE-99, are likely to be more toxic and bioaccumulative than other PBDE congeners. Although the toxicology of PBDEs is not completely understood, some studies on PentaBDE have demonstrated reproductive toxicity, neurodevelopmental toxicity and effects on thyroid hormones. The neurotoxic effects of PBDEs are similar to those observed for PCBs and so children exposed to PBDEs are likely to be prone to subtle but measurable developmental problems. It is believed that long-time exposure to lower doses of PentaBDE can cause health effects, since PentaBDE accumulates in the human body. Vulnerable groups could be pregnant women, embryos and infants, because of effects on the thyroid hormone balance, and the embryo's development of the central nervous system. Some studies of ecotoxicity indicate reproductive effects on colonies of plankton and a greater risk for the bioaccumulation of PentaBDE in organisms higher in the food chain.

7.5 Regulations at the international, regional and national levels

135. In 1998, the commission of the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention)⁶, focused on guiding international cooperation on the protection of the marine environment of the North-East Atlantic, placed PBDEs on its "List of Chemicals for Priority Action." At the 4th North Sea Conference, it was decided to phase out the use of brominated flame retardants by 2020.

136. C-PentaBDE was nominated as a new POP under the UNECE Convention on Long-range Transboundary Air Pollution⁷ in 2004 by Norway. At the time of development of the risk profile of c-PentaBDE, the UNECE Task Force on POPs continues with the review and further explore management strategies of this chemical.

137. The EU notified PentaBDE to the Rotterdam Convention in 2003. For it to become a candidate, bans of the substance must be notified by two parties under the Convention from different regions.

138. The Arctic Monitoring and Assessment Programme (AMAP) is another international initiative conducting research to reduce the use of brominated flame retardants.

139. At national level, Australia has banned the use of PentaBDE in new articles, although imports of articles containing BFRs are not regulated. In US the industry voluntarily ceased production of c-PentaBDE from 2005, and the use is forbidden in some states. US EPA requires notification and Agency review prior to restart of manufacture for any use. In Japan the use of c-PentaBDE stopped voluntarily in 1990. Norway and Switzerland have banned production, import, export and marketing and use of PentaBDE and mixtures containing 0.1 percent per weight or more of PentaBDE. Products containing more than 0.25 % PentaBDE are classified as hazardous waste when they are discarded. In Norway recycling and reuse of PentaBDE and materials with PentaBDE are not allowed. In Canada there is no production of PentaBDE and will be implementing virtual elimination for the tetra-, penta- and hexa-BDE homologues contained in c-PentaBDE through regulations on manufacture, use, sale and import (SFT, 2007b).

⁶ <http://www.ospar.org/>

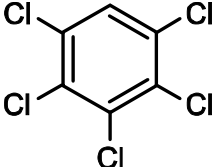
⁷ <http://www.unece.org/env/lrtap/>

140. In 2006, China promulgated a law similar to the EU RoHS Directive. When fully implemented, it will prohibit c-PentaBDE and c-OctaBDE use in new electric and electronic equipment. Implementation of phase 1 of the law (marking and disclosure only) came into effect March 1, 2007; implementation schedule for Phase 2 (full restriction) has not been determined.

8. Pentachlorobenzene

141. Pentachlorobenzene is listed in Annex A and C of the Stockholm Convention; hence production and use have to be eliminated by Parties without exemptions. Unintentional releases have to be reduced through implementation of Best Available Techniques and Best Environmental Practices (BAT/BEP), when appropriate.

8.1 Chemical and physical properties

Chemical identification and physical properties	
Chemical name:	Pentachlorobenzene
Synonyms/abbreviations:	1,2,3,4,5-pentachlorobenzene; , benzene, pentachloro-; quintochlorobenzene; PeCB
CAS registry number:	608-93-5
Structure:	
Molecular weight	250.32
Molecular formula:	C ₆ HCl ₅

142. Pentachlorobenzene (PeCB) belongs to the group of chlorobenzenes. It has been used in the past as a pesticide, flame retardant, and combined with PCBs in dielectric fluids. It is not clear whether it is still used as a pesticide or flame retardant on its own; however, it can be found as an impurity in pentachloronitrobenzene (quintozene) and other pesticides such as Clopyralid, Atrazine, Chlorothalonil, Dacthal, Lindane, Pentachlorophenol, Picloram and Simazine.

143. The estimated half-life of PeCB is 45 to 467 days. Although photodegradation in surface water is fast under sunlight irradiation, under field conditions the strong adsorption to solids may counteract this process. The half-life of PeCB in surface water is estimated to range from 194 to 1,250 days, while the estimated half-life for the anaerobic biodegradation in deeper water range from 776 to 1,380 days. It is expected that if PeCB is released to soil, it will absorb strongly to the soil and will not leach to the groundwater. PeCB appear to be very persistent in soils, water and the atmosphere, based on actual measurements and experimental estimates. PeCB is bioaccumulable and has a high potential for bioconcentration.

144. The small spatial variability in the ranges of air concentrations across the Northern Hemisphere indicates that PeCB has a very long atmospheric residence time and is widely distributed in the global hemisphere. The presence of PeCB in matrices from remote regions, some that can only have received PeCB after transport via air, supports the conclusion that PeCB is subject to long range transport.

8.2 Production, export and trade information

145. Pentachlorobenzene had been produced commercially in the European member states of UNECE, but it is not produced any more. Canada and the US reported that there is no current domestic commercial demand for PeCB and that it is not used as an end product. Ullmann's Encyclopedia of Industrial Chemistry does not mention any present use of PeCB. The situation in other parts of the world is less clear.

146. Most of the countries that submitted information during the information collection for the evaluation of PeCB in the POPRC reported no production (Canada, Czech Republic, Germany, Lithuania, Mauritius, Turkey, and US). No trade or stockpiles have been reported.

8.3 Main uses and applications

147. PeCB was a component of a chlorobenzenes mixture used to reduce the viscosity of PCB products employed for heat transfer, but new regulations prohibiting new uses of PCB-containing dielectric fluids resulted in a decline of the use of PeCB after 1980. PCBs are still in use in some old electrical equipment so that there is a small potential for release of PeCB from this source. PCBs are being taken out of service in many countries of the world so that any related PeCB emissions are expected to decrease with time.



148. PeCB has been used as a chemical intermediate in the manufacture of pentachloronitrobenzene (quintozene) and it is found as an impurity in this fungicide. Report on the production and use of quintozene in various countries indicated that the use outside the UNECE region is unknown.

149. PeCB may have been used in the past as a fungicide and as a flame retardant, it was formerly used in a pesticide to combat oyster drills. Formerly, PeCB and tetrachlorobenzene (TeCB) could be found in dyestuff carriers. The applications in dye carriers have been discontinued.

8.4 Risk profile

150. PeCB can be released to the environment by incineration of waste, barrel burning of household waste; in waste streams from pulp and paper mills, iron and steel mills, petroleum refineries; and in activated sludge from waste water treatment facilities.

151. PeCB is spread widely in the global environment. Unintentional release of PeCB as a by-product of incomplete combustion appears to be the largest current source. Although the production and use of PeCB has ceased in most countries, its reintroduction remains possible.

152. Occupational exposure to PeCB may be through inhalation and dermal contact with this compound at workplaces where it is produced or used, e.g. wood treatment plants, dielectric fluid spill and cleanup, municipal solid waste incinerators, hazardous waste incinerators, and magnesium production plants. Exposure may also arise in occupational settings where the pesticide quintozene is produced and used. The general population may be exposed to PeCB via inhalation of ambient air, ingestion of food and drinking water. Case reports of adverse effects in individuals, or epidemiological studies of populations exposed to PeCB have not been identified.

153. PeCB has been detected in breast milk and found to accumulate in human placenta and has also been measured in abdominal, mammary, and perirenal fat tissue from 27 adult Finnish males and females. Workers with occupational exposure to PeCB were found to have higher levels of the substance in blood than control groups.

154. PeCB is classified within the EU as "Harmful if swallowed" and "Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment". PeCB shows adverse effects for acute and subchronic toxicity, it causes affection to liver and kidney, such as increased weight and histopathological changes.

155. PeCB has teratogenic effects in mammals at high doses, in suckling pups developed tremors, and in pregnant female rats the mean fetal weight was decreased in the highest dose group.

156. Acute toxicity and chronic toxicity to PeCB affects marine and freshwater organisms even at low values ($\mu\text{g/L}$). Based upon acute and subchronic animal tests, PeCB is probably moderately toxic to humans and based on experiments with aquatic species, toxic for a range of aquatic organisms.

8.5 Regulations at the international, regional and national levels

157. PeCB is not included in any international convention. The European Commission has submitted a proposal to include PeCB to the Protocol to the 1979 Convention on Long Range Transboundary Air Pollution (LRTAP) on Persistent Organic Pollutants to the Executive Secretariat of the United Nations Economic Commission for Europe in 2006.

158. PeCB is identified as a priority substance within the European Water Framework Directive (2000/60/EC). Within the list of these priority substances so-called priority hazardous substances are identified which are of particular concern for the freshwater, coastal and marine environment. These substances will be subject to cessation or phasing out of discharges, emissions and losses within 20 years after adoption of the Directive. The European Commission has proposed to include PeCB as a priority hazardous substance. PeCB is listed on the OSPAR 1998 List of Candidate Substances.

159. At national level, PeCB is included under the Prohibition of Certain Toxic Substances Regulations, 2005, in Canada. These regulations enacted a ban on the manufacture, use, sale, offer for sale and import of PeCB or any mixture or product containing these substances, but allows exemptions where they are used with PCBs. In the Czech Republic, PeCB is part of an integrated monitoring programme on POPs. This programme will provide information on the Central European levels of POPs, the long-term trends in those levels and the impact of various sources and the effectiveness of measures applied to reduce the impact. The chemical was not manufactured nor imported in the Republic of Korea and is neither produced nor used in the Republic of Mauritius. In Moldova, PeCB is not included in the official register of permitted substances for importation and use in agriculture, including individual farms, forestry and household. PeCB will be banned in Moldova by the new National Chemicals Management Law, which is currently under development. In the United States, PeCB is subject to a US Toxic Substances Control Act (TSCA) Significant New Use Rule, requiring notification to EPA prior to manufacture, import or processing of 10,000 pounds (4,536 kg) or more of PeCB per year per facility for any use subject to TSCA. No such notification has been received.

9. Perfluorooctane sulfonate

160. Perfluorooctane sulfonate (PFOS) and 96 PFOS-related substances were proposed as a POP candidate by Sweden in 2005. When the proposal to list PFOS was assessed, the POPRC concluded that the best approach to address these substances was to list perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride. As per the decision of the Conference of the Parties, those substances are listed in Annex B of the Stockholm Convention; hence production and use are allowed for the following acceptable purposes and specific exemptions for production and use in accordance with Part III of Annex B:

- **Acceptable purposes:** Photo-imaging, photo-resist and anti-reflective coatings for semi-conductor, etching agent for compound semi-conductor and ceramic filter, aviation hydraulic fluids, metal plating (hard metal plating) only in closed-loop systems, certain medical devices (such as ethylene tetrafluoroethylene copolymer (ETFE) layers and radio-opaque ETFE production, in-vitro diagnostic medical devices, and CCD colour filters), fire-fighting foam, insect baits for control of leaf-cutting ants from *Atta spp.* and *Acromyrmex spp.*
- **Specific exemptions:** Photo masks in the semiconductor and liquid crystal display (LCD) industries, metal plating (hard metal plating, decorative plating), electric and electronic parts for some colour printers and colour copy machines, insecticides for control of red imported fire ant, and termites, chemically driven oil production, carpets, leather and apparel, textiles and upholstery, paper and packaging, coatings and coating additives, rubber and plastics.

161. Parties that want to continue the production and/or use of perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride need to notify the Secretariat of their intention to make use of an acceptable purpose and/or specific exemption. The Secretariat keeps registers for identifying Parties that have specific exemptions and/or acceptable purposes respectively that are available to the public. Other requirements according to Part III of Annex B are that Parties that use and/or produce these substances need to report every four years on programmes made to eliminate these substances; take into account guidance on best available techniques and best environmental practices, take action to phase out uses when suitable alternatives substances or methods are available; develop and implement an action plan as part of the national implementation plan; and promote research on and development of alternatives.

9.1 Chemical and physical properties

162. Perfluorooctane sulfonate (PFOS) is a fully fluorinated anion which is used as such in some applications or incorporated into larger polymers. It is also commonly used as a salt. PFOS and its related substances, referred to as "PFOS precursors" which can transform or degrade into PFOS, are members of the large family of perfluoroalkyl sulfonate substances. Although the ultimate net contribution of individual PFOS-related substances to the environmental loadings of PFOS cannot be predicted easily, there is a potential that any molecule containing the PFOS moiety could be transformed or degraded into PFOS.

163. When discussing the listing of PFOS, the POPRC concluded that the anion itself should not be listed since it never occurs in isolation, but always with a counter cation. The decision to list perfluorooctane sulfonic acid and its salts was based on the assumption that all salts are ionized and given the extreme persistence of PFOS, the salts would dissociate in the environment to liberate the anion. In addition, perfluorooctane sulfonyl fluoride (PFOSF) was added to the listing, since it is the most common starting material for the synthesis of the different types of PFOS-related substances presently used. PFOSF is a clear precursor of PFOS in the environment. By listing PFOSF together with PFOS acid and its salts, all possible derivatives of PFOS should be covered.



Chemical identification and physical properties	
Chemical name:	Perfluorooctane Sulfonate (PFOS); Octanesulfonate, 1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluoro-
Synonyms/abbreviations:	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-n-octanesulfonic acid; Perfluorooctanesulfonic acid; Perfluorooctylsulfonic acid
CAS registry number:	PFOS, as an anion, does not have a specific CAS number. The listing under the Stockholm Convention includes the parent sulfonic acid (CAS No. 1763-23-1), perfluorooctane sulfonyl fluoride (CAS No. 307-35-7) and some examples of its commercially important salts listed below: Potassium salt (CAS No. 2795-39-3) Diethanolamine salt (CAS No. 70225-14-8) Ammonium salt (CAS No. 29081-56-9) Lithium salt (CAS No. 29457-72-5) Tetraethylammonium perfluorooctane sulfonate (CAS No. 56773-42-3) Didecyldimethylammonium perfluorooctane sulfonate (CAS No. 251099-16-8)
Structure:	
Molecular weight:	506.1 (potassium salt)
Molecular formula:	C ₈ F ₁₇ SO ₃

164. PFOS is both lipid- and water-repellent, therefore, PFOS-related substances are used as surface-active agents in various applications. The extreme persistence of these substances makes them suitable for high-temperature applications and for applications in contact with strong acids or bases. The half-life of perfluorooctane sulfonate was determined to be over 41 years. Biodegradation of PFOS has also been evaluated under aerobic and anaerobic conditions. No apparent degradation occurred.

165. PFOS is not expected to volatilize significantly and is therefore assumed to be transported in the atmosphere predominantly bound to particles. The presence of PFOS in a wide variety of Arctic biota, far from anthropogenic sources, demonstrates its capacity to undergo long-range transport.

166. Perfluorooctane sulfonate does not accumulate in fatty tissue, is both hydrophobic and lipophobic, PFOS binds to proteins in the blood and the liver and in this way is both bioaccumulable and biomagnifying, which makes it reach high concentrations at high trophic levels.

9.2 Production, export and trade information

167. The main production process of PFOS and PFOS-related substances is electro-chemical fluorination (ECF), utilized by 3M, the major global producer of PFOS and PFOS-related substances prior to 2000. Other production methods for perfluoroalkylated substances are telomerisation and oligomerisation. However, to which extent these methods are applied for production of PFOS and PFOS-related substances is not evident.

168. The global production of PFOS by 3M from 1985 to 2002 is estimated to have been 13,670 tonnes. 3M's voluntary phase-out of PFOS production has led to a reduction in the use of PFOS-related substances. This is due not only to the limited availability of these substances (3M had at the time the greatest production capacity of PFOS-related substances in the world), but also to action within the relevant industry sectors to decrease companies' dependence on these substances.

169. Several companies exist that are believed to supply PFOS-related substances to the global market. Excluding the plant of 3M in Belgium, six plants are located in Europe, six are in Asia (one of them in Japan) and one in Latin America (Brazil).

9.3 Main uses and applications

170. Below is a list of applications of PFOS-related substances identified during the development of the risk management evaluation on PFOS based on information provided by Parties and observers. Some of the applications are still on-going in some countries.

- Fire fighting foams
- Carpets
- Leather/apparel
- Textiles/upholstery
- Paper and packaging
- Coatings and coating additives
- Industrial and household cleaning products
- Floor polishes
- Denture cleanser
- Shampoos
- Industrial and household cleaning products
- Use of existing fire fighting foam stock
- Photographic industry
- Photolithography and semiconductor
- Photomicroolithography
- Anti-erosion additive
- Anti-reflective coating
- Adhesion control
- Surfactant
- Intermediate
- Hydraulic fluids
- Metal plating

171. For agriculture, it has been used historically as pesticide and insecticide products for termite and ant bait to control leaf-cutting ants.

172. Stocks of PFOS and PFOS-containing products that were in existence at the time the US regulations were promulgated in 2002 could continue to be used in any application until they were consumed without violating the regulation, except that the PFOS-related insecticide products are subject to a phase-out agreement prohibiting their use after 2015.

9.4 Risk profile

173. PFOS and PFOS-related substances can be released to the environment during their manufacture, use in industrial and consumer applications, and from disposal of the chemicals or of products or articles containing them after their use.

174. The United Kingdom (UK) and Sweden have proposed the following classification for PFOS in EU (2005), which resume the facts observed in many studies with animals:

- T Toxic
- R40 Carcinogen category 3; limited evidence of carcinogenic effect
- R48/25 Toxic; danger of serious damage to health by prolonged exposure if swallowed
- R61 May cause harm to the unborn child
- R51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment



9.5 Regulations at the international, regional and national levels

175. In June 2003 PFOS was added to the list of Chemicals for Priority Action in OSPAR.

176. The Executive Body of the UNECE Persistent Organic Pollutants Protocol to the Long-Range Transboundary Air Pollution Convention (LRTAP) agreed that PFOS be considered a POP as defined under the Protocol on POPs and requested that the UNECE Task Force on POPs continue with the review of the substance and exploring management strategies.

177. The European Union has adopted Directive 2006/122/EC of the European Parliament and the Council Directive 76/769/EEC of the Council of 12 December 2006 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use and preparations of perfluorooctane sulfonates and related substances.

178. Australia has produced three Alerts concerning PFOS through its National Industrial Chemicals Notification and Assessment Scheme (NICNAS). PFOS- based chemicals are not currently manufactured in Australia; however products containing these chemicals have been made and are used in Australia.

179. Canada has proposed regulations to prohibit the production and use of PFOS and its salts and substances that contain on of the following groups: $C_8F_{17}SO_2$, $C_8F_{17}SO_3$ or $C_8F_{17}SO_2N$ (Canada Gazette, vol. 140, No 50, December 16, 2006).

180. The United States Environmental Protection Agency (US EPA) has adopted federal Significant New Use Rules (SNURs) for 88 PFOS substances which apply to new manufacture and new uses of these substances. Further, a final SNUR for 183 additional perfluoroalkyl sulfonate substances was issued in October 2007 (72 FR 57222, October 9, 2007). The SNURs require manufacturers and importers to notify the US EPA at least 90 days before manufacture or import of these substances for any use other than certain narrow, ongoing uses. The US EPA also negotiated a phase-out of PFOS-related pesticide products containing sulfluramid.

Chapter 2. IMPLICATIONS FOR PARTIES

2.1 Obligations under the Stockholm Convention

181. The Conference of the Parties (COP) to the Stockholm Convention is sovereign in deciding on the listing of substances. At its fourth meeting in May 2009, the COP adopted a number of decisions for the listing of nine additional POPs under the Convention, as indicated in chapter 1 of this document.

182. For most Parties, the nine new POPs entered into force on 26 August 2010, one year after the date of communication by the depositary of the adoption of the amendments. The amendments have not entered into force for those Parties that had submitted a notification of non-acceptance in accordance with the provisions of paragraph 3(b) of Article 22 or a declaration upon ratification of the convention in accordance with paragraph 4 of Article 22 and paragraph 4 of Article 25 of the Convention that amendments to Annex A, B or C only enter into force upon ratification of the amendment. As of December 2010, the amendments entered into force for 153 of the 172 Parties to the Convention, one Party submitted a notification of non-acceptance and 18 Parties need to ratify the amendments for them to enter into force.

183. In compliance with the Convention, Parties for which the new POPs have entered into force must therefore implement measures to reduce or eliminate production, uses and releases of the new POPs as called for in the Convention (Articles 3, 5, 6), and report these efforts to the Secretariat.

184. It is recommended that short, medium and long terms goals are clearly defined when designing strategies to successfully accomplish relevant obligations, and that cooperative work to build on policies and laws and to improve capacities is agreed and conducted among stakeholders. In addition, and in order to avoid unnecessary duplication of efforts, an efficient cooperation and coordination mechanisms should be established.

185. When addressing the risks associated to POPs emissions and exposure, it is necessary to consider and implement management practices that minimize these risks. In this aspect, compliance with Stockholm Convention obligations requires Parties to report on progress made through NIPs to address priorities at the national level. Relevant implications for Parties, as well as several recommended activities to support implementation efforts for the new POPs, are briefly described in this chapter of the guidance document.

2.2 Updating the National Implementation Plan

186. According to Article 7 of the Stockholm Convention, each Party shall review and update its National Implementation Plan (NIP) within two years of the date of entry into force of the amendment adding a new chemical in Annex A, B, or C of the Convention for that Party. The updated NIP should include the action plans to eliminate or restrict newly listed chemicals in accordance with the objective of the Stockholm Convention. In order to prioritize and decide on the national action plans for reducing and phasing out of the new POPs, it is important to identify the use/production, import/export/, and stockpile/waste of new POPs within the country, establish inventories, undertake assessment on socio-economic impact as well as environmental and health implications.

187. Eligible countries can apply for financial support to carry out this exercise. They may either contact the Global Environment Facility (GEF) directly or carry out the NIP update through one of the GEF Implementing Agencies, for example the United Nations Environment Programme (UNEP), the United Nations Development Programme (UNDP), the World Bank or the United Nations Industrial Development Organization (UNIDO).

188. There are number of guidance for developing and updating a NIP and are available at the website of the Stockholm Convention (www.pops.int):

- Guidance for developing national implementation plans for the Stockholm Convention (UNEP/POPS/COP.2/INF/7)
- Guidance for the review and updating of national implementation plans (Annex to decision SC-1/12)
- Elaborated process of reviewing and updating national implementation plans (Annex to decision SC-2/7)
- Guidance on socio-economic assessment for national implementation plan development and implementation under the Stockholm Convention (UNEP/POPS/COP.3/INF/8)
- Guidance on calculation of action plan costs, including incremental costs and action plans for specific persistent organic pollutants (UNEP/POPS/COP.4/INF/11)

189. In addition, guidance materials focused on brominated flame retardants and on PFOS and its related substances are in preparation to support Parties to review and update their NIPs in a timely manner.

2.3 Legislation for the new POPs

190. Many countries, which are Parties to the Stockholm Convention, have established a foundation for chemicals management through regulatory instruments that support compliance with Convention obligations. The current legal



framework for POPs at the national level will need to be reviewed to ascertain that it adequately addresses the obligations that are the result of listing new POPs. If necessary, this framework will need to be updated and appropriate policy instruments, including non-regulatory approaches, developed.

191. A process to update existing regulation for chemicals management can be a lengthy one, as it usually requires an extensive stakeholder consultation and public review, for both technical and legal issues. When a new or updated regulatory scheme is expected to take a long time to enter into force, initial management practices can be implemented through non-regulatory approaches in coordination with the industrial sector or other relevant stakeholders. For example, a voluntary scheme could promote emission reductions or environmental sound management of POPs waste at the source. This initial progress can help Parties comply with Convention obligations before a full regulatory programme is implemented.

2.4 Inventories, monitoring and reporting

2.4.1 Inventories

192. An inventory is aimed to compile, keep current, and publish a list of each chemical substance that is manufactured or processed in a country. National inventories are becoming an increasingly important tool for countries to report on priority chemicals, such as POPs, and are generally considered as a vehicle for public access to information. Inventories can be considered as a basic instrument to help establish management strategies and policies for the sound management of chemicals as they identify major sources of releases and provide estimates of amounts used, released and disposed of.

193. Once amendments to Annexes A, B or C of the Convention adding new POPs enter into force, Parties are required to develop inventories for those substances so that information at the country level becomes available. This task is similar to the one for other substances during the initial NIP process. As a first step Parties may conduct an initial assessment to identify the presence (production, use, etc.) of the new POPs within the country, and then prioritize which ones need a national inventory. Specific activities include: the development of a preliminary inventory on production, distribution, use, import and export; an inventory of stocks and contaminated sites and products; evaluation of management options for obsolete stocks; and an inventory of releases to the environment. Participation of key stakeholders will help to ensure that necessary information is made available; and further to strengthen the reliability of the results. Due to the complexity of certain industrial chemicals, such as PFOS, it may be necessary to develop a toolkit for their identification and quantification.

2.4.2 Monitoring

194. Recognizing that one of the properties of POPs is the potential for long range transport, and that these chemicals are routinely found in places where they have never been used or produced, it is necessary to consider the usefulness of measuring environmental levels of these pollutants and changes over time. Monitoring efforts should also consider hot spots or potentially contaminated sites around the country, including sites of facilities where manufacture of the new POPs has taken or is still taking place. Parties need to consider the benefits of regular monitoring data and include the new POPs in existing national, regional and global monitoring programmes, as appropriate.

195. When developing or updating monitoring strategies, countries can benefit from strengthened monitoring capacity and obtain data to support policy development and decision-making on chemicals and their management. Monitoring efforts should aim at producing high quality information that can form part of the Global Monitoring Plan (GMP), which is used for the effectiveness evaluation of the Convention.

2.4.3 Reporting

196. One of the obligations of Parties is to provide information on national measures taken to implement the relevant provisions of the Stockholm Convention and on the effectiveness of such measures in meeting the objectives of the Convention. These include measures to reduce or eliminate releases from intentional production and use, as well as from unintentional releases of POPs. Additional information that is reported includes the identification of products and articles in use and wastes consisting of, containing, or contaminated with, chemicals listed in Annex A, B or C; the identification of stockpiles consisting of or containing chemicals listed in Annex A or Annex B; information on production, import and export of chemicals in Annexes A and B. The Stockholm Convention has established an On-line Electronic Reporting System, for the Stockholm Convention Official Contact Points (OCPs) and governmental officers responsible for national reporting under Article 15 of the Convention.

197. A good example of an information system for chemicals is a Pollutant Release and Transfer Registry, usually referred to as PRTR. Some of the main core elements of a PRTR include: the listing of chemicals, groups or categories of pollutants (e.g. POPs, heavy metals) that are released or transferred; and integrated multi-media reporting of releases and transfers (air, water and soil); reporting of data by source and on a periodic basis (preferably annually); and making data available to the public. It therefore provides a valuable tool to collect, analyze and disseminate information on chemicals of concern. PRTRs also aim at informing the public on environmental issues by providing data about releases of pollutants to the environment and compiling them in a publicly accessible database. PRTRs have been found to

contribute to reduction of releases of substances which may have a negative impact on the environment and human health. Though the main purpose of PRTRs is public disclosure of information, it may be necessary to include methods for handling confidential information when designing this type of system.

198. PRTRs are increasingly being used to support regional and international efforts to reduce chemical risks. Parties to the Convention may wish to consider conducting an assessment of national infrastructure and needs for the design and implementation of a PRTR, to meet the goals of information exchange on POPs under the Convention.

2.5 Applying for specific exemptions and/or acceptable purposes

199. Among the 9 new POPs, three chemicals in Annex A (lindane, tetrabromodiphenyl ether and pentabromodiphenyl ether, heptabromodiphenyl ether and hexabromodiphenyl ether) are allowed for continued use for a specified period provided that the Party has notified the Secretariat for registry of the specific exemption. The types of use allowed for these chemicals are as follows:

- Use of lindane: Human health pharmaceutical for control of head lice and scabies as second line treatment, in accordance with Article 4, for a period of five years from the date of entry into force of the amendment unless otherwise decided by the COP.
- Use of heptabromodiphenyl ether and hexabromodiphenyl ether in articles: Recycling of articles that contain or may contain these chemicals, and the use and final disposal of articles manufactured from recycled materials that contain or may contain these chemicals, in accordance with Part IV of Annex A, until 2030 unless otherwise decided by the COP.
- Use of tetrabromodiphenyl ether and pentabromodiphenyl ether in articles: Recycling of articles that contain or may contain these chemicals, and the use and final disposal of articles manufactured from recycled materials that contain or may contain these chemicals, in accordance with Part V of Annex A, until 2030 unless otherwise decided by the COP.

200. PFOS, its salts and PFOS-F is listed in Annex B with acceptable purposes and specific exemptions for its production and use provided that a Party has notified the Secretariat for registry of the acceptable purposes or the specific exemption.

201. Formats for notification of register for specific exemptions and acceptable purposes are available on the Stockholm Convention website (www.pops.int).

202. Specific exemptions that are in accordance with Article 4 are available for five years from the date of entry into force of the new chemical. If a Party wishes to extend the specific extension beyond this period, it needs to submit a report to the Secretariat justifying its continued need for that exemption. The Conference of the Parties will then review and decide upon the need for continued exemptions. When there are no longer any Parties registered for a particular type of specific exemption, no new registrations may be made with respect to it.

203. Acceptable purposes are open without a specific deadline. However, for PFOS, the Parties decided that each Party that uses and/or produces PFOS shall report on progress made to eliminate PFOS to the Conference of the Parties every four years pursuant to and in the process of reporting under Article 15 of the Convention. The Conference of the Parties will then evaluate every four years the continued need for the acceptable purposes of PFOS on the basis of available scientific, technical, environmental and economic information. The first review will take place no later than 2015.

204. In addition, pursuant to note (ii) of Annex A and B, Parties also need to register with the Secretariat chemicals contained in articles that were manufactured or already in use before the entry into force of the relevant obligation with respect to that chemical.

2.6 Capacity building

205. Many developing countries and countries with economies in transition still lack the technical capacity to fully develop and enforce chemicals management practices. When updating NIPs, Parties may want to include capacity building activities as part of their implementation efforts. This is particularly important for the new POPs, for which domestic information may not be available, making it more difficult to develop appropriate risk reduction measures.

206. When identifying capacity-building and technical assistance needs to reduce and prevent pollution from POPs, special attention should be given to the capacity to implement specific priorities and activities for the new POPs which have been identified during the updating of the NIP. Existing capacity building programmes, including those established during initial NIP development can be revised and updated to address the new POPs. It is also recommended that these programmes include all relevant stakeholders.

207. For instance, strengthening of enforcement efforts of customs departments is one area that has been cited as important for several Parties. In this aspect, the creation of specific tariff codes for the new POP chemicals and related products can facilitate the tracking of these chemicals at the port of entry with customs facilities, and provide more accurate data on imports and exports. Specialized training can be provided to customs officials so that they are able to



identify the new POPs and ensure that materials are handled as required. This effort will help remove materials that could be harmful to human health and the environment from commerce.

208. In general terms, specialized training should be provided to officers responsible for the management of hazardous substances and other relevant stakeholders.

209. The scientific community is usually active in obtaining field and monitoring data through research projects, which can provide information on the effects and levels of chemicals of concern. However, universities and research centers sometimes lack the necessary infrastructure (human and technical) to conduct these types of studies that support decision-making at the national level on a regular and consistent basis. When updating NIPs, Parties could consider capacity building efforts for research and monitoring, to obtain national information on the new POPs. These may also include work to promote the development of scientific expertise in the field of modeling of pathways in the environment, and the use of these models for the new POPs.

210. A regional approach for analytical capacity strengthening may support research and monitoring of POPs at the domestic level. This type of scheme could be implemented by the Stockholm Convention regional centers. It is also recommended that action plans are developed in coordination with regional centers, as appropriate. Furthermore, regional centers should share information on the areas of technical support and capacity building in which countries may require assistance.

211. Several international organizations such as the Organisation for Economic Co-operation and Development (OECD), the World Health Organization (WHO), the Food and Agriculture Organization (FAO), the United Nations Institute for Training and Research (UNITAR) the United Nations Environment Programme (UNEP), the Society of Environmental Toxicology and Chemistry (SETAC), publish technical documents and additional guidance materials that provide knowledge and expertise on issues related to POPs (See chapter 2). These and other organizations frequently offer training workshops to assist developing countries and countries with economies in transition. Parties are encouraged to engage and participate actively in bilateral, regional or global cooperation programmes that include capacity building activities for the assessment and management of chemicals, including POPs.

2.7 Communication and awareness raising

212. Public awareness and participation play significant roles in the successful implementation of the Convention at the national level and contribute to the global effort to minimize the risks to human health and the environment from exposures to POPs. The Stockholm Convention requires Parties to exchange information (article 9), facilitate public information, awareness and education (Article 10), report to the Secretariat (Article 15) and periodically update implementation plans (Article 7).

213. Implementing a mechanism to exchange information regarding emerging chemical issues that can identify and spur action on additional chemicals of concern is a key task for Parties, and one that may be considered when the NIP is reviewed and updated to address the new POPs. An important aspect of communication and awareness raising is to facilitate the meaningful participation of the public, including non-governmental organizations, business and industry, indigenous people, provincial, state and municipal governments, academia, and technical and policy experts so that POPs are managed in an environmentally sound manner.

214. Aspects that Parties can consider when designing strategies for disseminating information related to the new POPs include:

- Communication of NIP updates and their implications to all sectors of society
- Provision and promotion of outreach and education activities to all actors and partners (for example, industry, NGOs, schools, universities, and worker associations)
- Communication of appropriate strategies for reduction and elimination of uses and releases, including promotion of the use of safer alternatives
- The development of effective partnerships to enhance capacity
- Development of reading-friendly fact sheets with general information, known risks and potential environmental and human health impacts of the new POPs
- Sharing information on policies, laws and regulations, in particular new regulatory actions
- Promotion stakeholders engagement in implementation activities

215. The Secretariat of the Stockholm Convention may also play an important role in compiling and making ready-made materials available in order to raise awareness on relevant topics related to POPs. These materials could include public awareness documents developed during NIP processes, presentations used during workshops, etc. Subject to the availability of resources, either the Secretariat or Parties could translate these materials to make them available in the six UN languages, and use them for awareness raising in their countries.

216. Additional areas for information sharing and dissemination include: the presence of new POPs in products; producers and users of new POPs at the domestic level; Best Available Techniques (BAT)/Best Environmental Practice (BEP) applicable to PFOS; contaminated site remediation, and effective, affordable and cost effective alternatives for the new POPs.

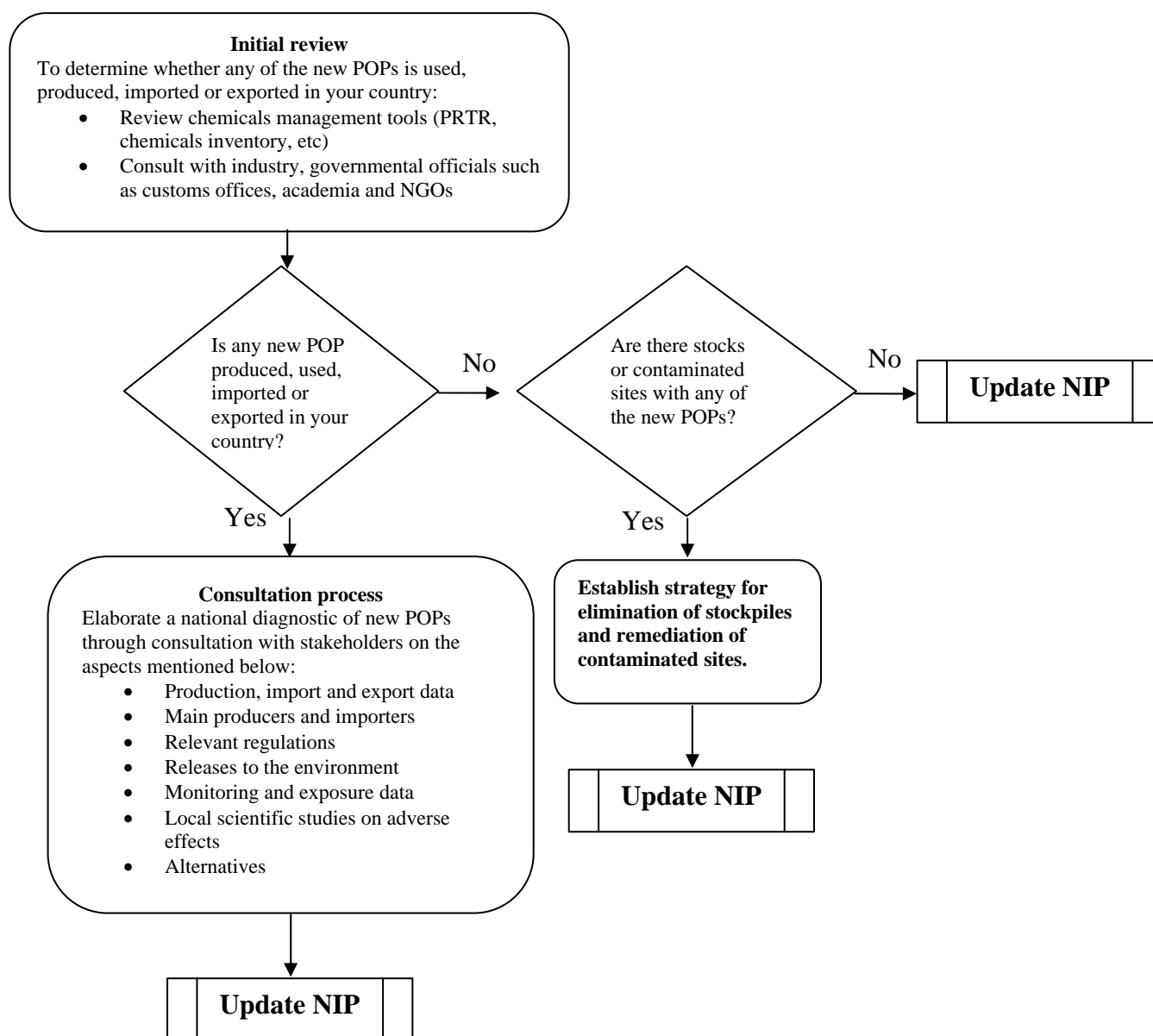
217. The Secretariat could also facilitate the establishment of an information exchange mechanism among Parties. Regional Centers should also take part in this mechanism and distribute materials within countries in the region (e.g. newsletters, technical information in support of BAT/BEP implementation). The creation of specialized networks could be a further option for information exchange on the new POPs.



Chapter 3. INFORMATION SOURCES FOR THE NEW POPs

218. Amending the Annexes A, B or C of the Convention to list new POPs triggers a row of obligations for Parties to the Convention explained in chapter 2 of the present document. In order to be able to implement those measures, Parties need to know whether the concerned chemicals are produced, used and imported in their countries. Parties therefore need to conduct an assessment on the current situation of each of the new POPs at the national level, as a starting point to update the National Implementation Plan (NIP) and identify the need to apply for exemptions and/or acceptable purposes. The outcome of this preliminary work may then be used to identify and implement strategies to comply with obligations under the Convention.

219. The flow chart below indicates the suggested steps to follow for addressing the new POPs:



3.1 National databases and/or information systems

220. Many different policy instruments and tools, such as data and information systems, are used to support chemicals management and decision making in the various countries. The following sections describe tools that are useful to gather information for a national evaluation of POPs.

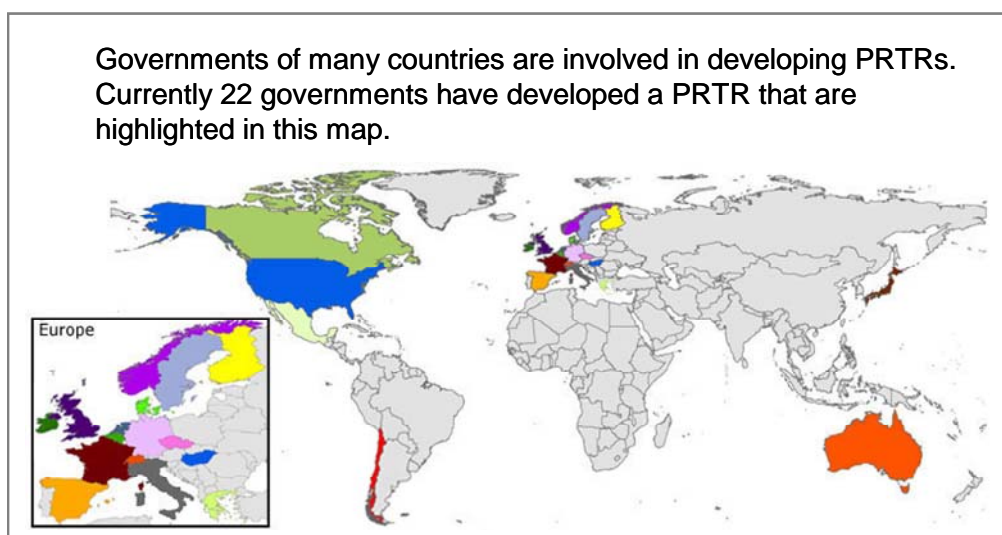
3.1.1 Public sector

a) Pollutant Release and Transfer Register

221. A Pollutant Release and Transfer Register (PRTR) is a national or regional environmental database or inventory of potentially hazardous chemical substances and/or pollutants released to air, water and soil and transferred off-site for treatment or disposal. The chemical substances included in the database are considered a priority for the specific country and some of the nine new POPs may be included. In general, industrial or business facilities quantify and report the amounts of substances released to each environmental medium (air, water, soil) or transferred off-site for waste management or wastewater treatment. Some PRTRs also include estimates of releases from diffuse sources, such as agriculture, transport or end-of-life products.

222. PRTRs provide public access to data via the Internet, CD-ROMs, publications and annual reports. PRTR data may be presented geographically, either in a fixed form or interactively via the Internet. Data may be presented by industry sectors, by facility, by chemical substance or groups of substances. National PRTRs may vary in terms of hazardous chemicals and pollutants reported, industry or business categories that must report and the destination of releases.

223. PRTRs are generally compiled by environmental authorities and provide valuable quantitative information on chemicals that are released or transferred to the environment. This tool also supports priority setting exercises to define programmes aimed at reduction of releases (OECD, 2009).



Source: (OECD, 2009)

b) Existing chemicals inventories

224. A chemical inventory is a list of chemicals that have been or are manufactured in or imported into a country. It is used primarily to distinguish between existing and new chemicals, which are then subject to notification and assessment requirements prior to their introduction into the market. An inventory is a database created from information submitted to government authorities by manufacturers, processors, users, and/or importers. The content of an inventory can range from only the CAS numbers and/or names of chemicals in commerce at the time the inventory was compiled, to the amount produced and imported by location, and used for different purposes (UNEP, 1999). A chemicals inventory may be a direct source of information to identify if the new POPs are on the market in the country, and possibly the amount of POPs manufactured or imported. Several countries have already developed a chemicals inventory as listed below:

- United States (<http://www.epa.gov/oppt/newchems/pubs/invntory.htm>)
- Canada (<http://www.ec.gc.ca/substances/ese/eng/dsl/dslprog.cfm>)
- Australia (<http://www.nicnas.gov.au/Industry/AICS.asp>)
- Korea (<http://newchem.nier.go.kr/eng/notification/data/inventory.html>)
- The Philippines ([http://www.emb.gov.ph/chemicals/PICCS Information.htm](http://www.emb.gov.ph/chemicals/PICCS%20Information.htm))



c) **Registration schemes for pesticides and other hazardous substances**

225. In order to allow companies to use and/or commercialize a pesticide or hazardous substance in a country, many governments have established a registration scheme to assess chemicals risks to humans and the environment. The assessment of risks is important because it provides governments the basis for decisions on approving a new chemical or renewing the registration of existing ones. National authorities in charge of the registration process are usually environmental, health or agricultural agencies. In general, a public database provides information on which pesticides or hazardous substances are authorized for use or commercialization in the country. Since some of the new POPs may be pesticides that have been banned, historical registrations should also be reviewed.

d) **Customs and trade offices**

226. Most chemicals are subject to international trade, and as many other consumption goods they have a custom tariff assigned. A custom tariff is a tax assessed by a government on goods that are moved across an international border crossing or port. Since the import, export and transit of goods have an impact on the economy of a country, governments keep a record of the goods under international trade. Each good is classified by a specific customs tariff code assigned by the country. Most countries use harmonized tariffs schedules and classification system. One commonly used standard is the Harmonized Commodity Description and Coding System, which is maintained by the World Customs Organization (<http://www.wcoomd.org/home.htm>). This system is internationally standardized, and it uses names and numbers for classifying traded products.

227. Countries may have a database recording traded products, which is usually managed by a customs administration office in the Treasury Department. The database may contain the customs tariff code of the good, information on the importer, a description of the product and quantities of the good imported or exported. This database constitutes a relevant source of information for countries, and it may give an indication of whether the new POPs are imported or exported to or from the country. Information requests can be made to the customs office by using the trade name of the chemical substance or the specific customs tariff code.

228. Custom codes and thus trade data might have several limitations, such as the lack of specific codes for all chemicals in commerce. It is for example common to register a group of chemicals under a single code. Nevertheless, these databases can be considered an important source of information, including for products that may contain a group of chemicals with similar properties (e.g. polybrominated flame retardants in electronic goods).

3.1.2 Industry

229. One of the functions of industry or trade associations is the publication of periodical reports on the performance and achievements of industrial and commercial activities. Chemical and manufacturing industry associations can be useful sources of statistics on production and/or importation of new POPs or products than may contain them. The industry is also a potential source of information on alternatives. Information can be gathered through direct dialogue with industrial and commercial partners or through reports available in documentation centres or on their websites. A fee may be charged to access the information.

3.1.3 Academia

230. Research institutes and universities play an important role in the generation of scientific information such as data on levels of hazardous substances in humans and the environment and the risks associated to exposure. These institutions may also be involved in identifying and developing alternatives to toxic chemicals. It is therefore useful to identify research institutes and universities that carry out this type of research. Information may be available through a council for research and technology or similar bodies, which provide information on national research and academic programmes and the results of scientific studies carried out in universities and research centres.




3.1.4 Other

231. Non-governmental organizations (NGOs) that work on environmental and health issues keep a close relationship with communities and can have a better knowledge of risk in local areas. Studies performed by NGOs can provide evidence of local impacts of hazardous substances, as well as pilot initiatives for alternatives.


3.2 Databases

232. The following tables show databases and sources of information made available by international organizations and various sectors (government, industry, academia and civil society) that may prove useful when gathering data on the new POPs.


3.2.1 Government databases

Source of information	Objective/content	Location
The United States Agency for Toxic Substances and Disease Registry (ATSDR)	A toxic substances portal that contains information on chemical characteristics, exposure risks, associated health effects, and health studies and assessments.	http://www.atsdr.cdc.gov/substances/index.asp 
Canada's Existing Substances Assessment Repository (CESAR)	It contains risk and other regulatory assessment reports on existing chemicals which include individual substances, groups or classes of chemicals, or effluents or wastes that are produced or imported in Canada or released into the Canadian environment.	 http://www.chemicalsubstanceschimiques.gc.ca/about-apropos/assess-eval/caes-ecse/index-eng.php
The Chemical Risk Information Platform (CHRIP) of the National Institute of Technology and Evaluation (NITE) in Japan	It presents information on the result of biodegradation and bioconcentration tests and the testing condition of Existing Chemical Substances under the Chemical Substances Control Law of Japan.	 http://www.safe.nite.go.jp/english/kizon/KIZON_start_hazkizon.html
Finnish Data bank of Environmental Properties of Chemicals – EnviChem	The main content of the database consists of information on the toxicity of substances in relation to different species, especially aquatic organisms, together with information on the persistence and accumulation of these substances in the environment.	http://www.ymparisto.fi/default.asp?contentid=141944&lan=en




3.2.2 Research and scientific databases

Source of information	Objective/content	Location
Cleaner solutions database TURI - Toxics Use Reduction Institute	From testing performed at the TURI Laboratory, a wealth of data have been accumulated on the performance of industrial and institutional cleaning products.	 http://www.turi.org/

3.2.3 Non-government organizations

Source of information	Objective/content	Location
International HCH and Pesticides Association	Documents and studies on lindane and other isomers of the hexachlorocyclohexane.	 http://www.ihpa.info/

3.2.4 Databases of international organizations

Source of information	Objective/content	Location
<p>Stockholm Convention</p> <p>Risk profile and risk management evaluation of substances under consideration by the POPs Review Committee</p> <p>Handbook for effective participation in the work of the POPs Review Committee</p>	<p>The POPs Review Committee of the Stockholm Convention elaborates a risk profile and risk management evaluation of each substance proposed for inclusion under the Convention. Both documents constitute an important and reliable source of information on the new POPs.</p> <p>The Handbook describes the objective and activities of the POPs Review Committee and presents a methodology for identification and compilation of information.</p>	 http://www.pops.int/poprc/
Centre for PRTR Data of the OECD.	<p>This database is the first step to share PRTR data across countries. It includes PRTR data from Australia, Belgium, Canada, England & Wales, Japan, the Netherlands, Scotland and the United States. Data of other countries and other years will be added to the database. PRTR data included in this database is compiled by national or regional level. The database does not include PRTR data of individual sources/facilities. This database can help users to share PRTR data regionally or internationally within the OECD member countries. Users can create a report of PRTR data according to years, countries, regions, industry sectors, chemicals, types of release sources, and types of releases and transfers.</p>	 <p>Centre for PRTR Data</p> http://www.oecd.org/env/5Fprtr%5Fdata/
PRTR.net	<p>This website provides a global portal to Pollutant Release and Transfer Register information and activities from countries and organizations around the world. The website aims to assist countries in the development, implementation and improvement of PRTR programmes. Particularly it contains information about PRTR developed by countries and by regions</p> <p>PRTR.net has been developed and is maintained by the Task Force on Pollutant Release and Transfer Registers (PRTRs) of the Organization for Economic Co-operation and Development (OECD).</p>	 http://www.prtr.net/

The Global Portal to Information on Chemical Substances of the OECD (eChemPortal)

eChemPortal offers free public access to information on properties of chemicals including physical and chemical properties; environmental fate and behaviour; ecotoxicity and toxicity.

eChemPortal allows for simultaneous search of multiple databases and provides clearly described sources. eChemPortal provides access to data submitted to government chemical review programmes at national, regional, and international levels including:

CESAR: Canada's Existing Substances Assessment Repository

CHRIP: The Chemical Risk Information Platform provided by the National Institute of Technology and Evaluation (NITE) in Japan

EnviChem: Data bank of environmental properties of chemical substances

ESIS: European chemical substances information system

HPVIS: High Production Volume Information System

HSDB: Hazardous substance data bank

HSNO CCID: New Zealand Hazardous Substances and New Organisms Chemical Classification Information Database

INCHEM: Chemical Safety Information from Intergovernmental Organizations

JECDB: Japan Existing Chemical Data Base

NICNAS PEC: Australian National Industrial Chemicals Notification and Assessment Scheme/Priority Existing Chemical Assessment Reports

OECD HPV: Organization for Economic Cooperation and Development (OECD) High Production Volume Database

SIDS UCLID: Screening Information Data Sets export files in for High Production Volume Chemicals in International Uniform Chemical Identification Database (maintained by OECD)





SIDS UNEP: OECD Initial Assessment Reports for HPV Chemicals including Screening Information Data Sets as maintained by UNEP

US EPA IRIS: United States Environmental Protection Agency Integrated Risk Information System

US EPA SRS: United States Environmental Protection Agency Substance Registry Services



<http://webnet3.oecd.org/echempportal/>

<p>European Pollutant Release and Transfer Register (E-PRTR)</p>	<p>The European Pollutant Release and Transfer Register (E-PRTR) is the new Europe-wide register that provides easily accessible key environmental data from industrial facilities in European Union Member States and in Iceland, Liechtenstein and Norway. It replaces the previous European Pollutant Emission Register (EPER). The new register contains data reported annually by some 24,000 industrial facilities covering 65 economic activities across Europe. For each facility, information is provided concerning the amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from a list of 91 key pollutants including heavy metals, pesticides, greenhouse gases and dioxins for the year 2007.</p>	 <p>http://prtr.ec.europa.eu/</p>
<p>Kiev Protocol on Pollutant Release and Transfer Registers to the Aarhus Convention</p> <p>Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters</p>	<p>The Protocol on Pollutant Release and Transfer Registers was adopted at an extraordinary meeting of the Parties to the Aarhus Convention on 21 May 2003. The Protocol is the first legally binding international instrument on pollutant release and transfer registers. Its objective is "to enhance public access to information through the establishment of coherent, nationwide pollutant release and transfer registers (PRTRs)." PRTRs are inventories of pollution from industrial sites and other sources.</p>	 <p>http://www.unece.org/env/pp/prtr.htm</p>
<p>Taking Stock: North American Pollutant Releases and Transfers</p>	<p>Taking Stock is an annual report that analyzes data reported under the pollutant release and transfer registers (PRTRs) of Canada, Mexico and the United States to obtain a North American picture of industrial pollution. The data are reported by industrial facilities under the three North American PRTRs: Canada's National Pollutant Release Inventory (NPRI); US Toxics Release Inventory (TRI) and Mexico's Registro de Emisiones y Transferencia de Contaminantes (RETC).</p> <p>Taking Stock Online, the CEC's integrated and searchable database, offers users the possibility to compare and analyze North American releases and transfers of pollutants by location, substance, facility and type of release or transfer, and to map the results.</p>	  <p>http://www.cec.org/takingstock/Default.aspx</p>



3.3 Addressing information gaps

233. Gathering information to determine the status of the new POPs at a national level can be a challenge, considering the diversity of information required and the possibility that it might not be readily available. This section provides a set of recommendations for addressing information gaps.

3.3.1 Establishment of a multistakeholder committee

234. A recommended strategy to cover information needs to identify the status of the new POPs is through consultations with the potential holders of the information. The experience obtained by Parties during the development of the National Implementation Plan (NIP), in which a wide range of stakeholders were involved to obtain specific knowledge and factual information, and gain their commitment for NIP implementation, has proven the usefulness of establishing a multistakeholder committee to fill information gaps related to the new POPs and assist in the update of the NIP. The technical unit that has lead responsibility for implementation of the Stockholm Convention is well placed to coordinate this committee.

235. Participants on the multistakeholder committee include government decision-makers and other officials involved in environmental protection, agriculture, public health, economic affairs, and international trade. It also includes representatives from social organizations involved in raising awareness on hazardous chemical substances; representatives from industry (for example associations for the electric and electronic sector, or agrochemical industry), and researchers from universities and research centres carrying out studies on chemical substances.

236. A set of forms has been developed to assist in collecting data required according to Annexes E and F of the Stockholm Convention for the evaluation of a potential POP. The multistakeholders committee can use these forms as a guidance to collect the information required for the review of the national situation. The forms can be found in the Handbook for Effective Participation in the Work of the POPs Review Committee (<http://www.pops.int/poprc/>).

237. Depending on existing coordination mechanisms and on identified priorities for the new POPs, a possible way forward can be for the committee to convene face-to-face meetings. The first one could focus on discussing initial steps, such as the need to elaborate an evaluation on the status of the new POPs at the national level and the information requirements to complete this task. A follow-up session could aim at presenting and discussing the information available, and the how any information gaps could be addressed. At a final meeting the results of the evaluation could be shared and input obtained to reach consensus on the findings.

3.3.2 Use of existing sources of information

238. The procedure to nominate and include a new chemical in Annexes A, B or C of the Stockholm Convention includes the development of risk profiles and risk management evaluations, which provide the foundation for making recommendations and taking subsequent decisions for listing new chemicals under the Convention.

239. The risk profile provides scientific evidence of the adverse human health and environment effects caused by the chemical under revision. The type of information included is the following:

- Production data, including quantity and location
- Uses
- Releases, such as discharges, losses and emissions
- Hazard assessment for the endpoint or endpoints of concern
- Environmental fate
- Monitoring data
- Exposure in local areas and, in particular, as a result of long-range environmental transport
- National and international risk evaluations, assessments or profiles and labelling information and hazard classifications
- Status of the chemical under international conventions

240. The risk management evaluation considers the socio-economic aspects associated with possible control measures that may be applied to the chemical under consideration. It presents information on the following aspects:

- Efficacy and efficiency of possible control measures in meeting risk reduction goals:
 - Technical feasibility
 - Costs, including environmental and health costs
- Alternatives (products and processes):
 - Technical feasibility
 - Costs, including environmental and health costs



- Efficacy
- Risk
- Availability
- Accessibility
- Positive and/or negative impacts of implementing possible control measures on the society:
 - Health, including public, environmental and occupational health
 - Agriculture, including aquaculture and forestry
 - Biota (biodiversity)
 - Economic aspects
 - Movement towards sustainable development
 - Social costs
- Waste and disposal implications (in particular, obsolete stocks of pesticides and clean-up of contaminated sites):
 - Technical feasibility
 - Cost
- Access to information and public education
- Status of control and monitoring capacity
- Any national or regional control actions taken, including information on alternatives, and other relevant risk management information.

241. Taking into account that the risk profile and the risk management evaluation documents are the result of an extensive technical review of relevant information provided by Parties and observers, they constitute a reliable source of information for Parties to fill information gaps. The risk profiles and the risk management evaluations of the nine new POPs can be consulted at: <http://www.pops.int/poprc/>.

3.3.3 Development and/or updating of information systems and databases

a) National surveys

242. With the support of a multistakeholder committee or as an initiative of the focal point or technical staff in charge of implementing the NIP, national surveys may be conducted as an additional mechanism to collect information. A survey can be useful to obtain data on production or use of a new POP in a specific industrial sector and to find out the opinions of manufacturers or downstream users/formulators of the substance concerning the impacts of restrictions or prohibition on the production or use of the new POPs. To be useful, the objective of the survey and the sector that will be surveyed should be clearly defined.

243. The forms used to compile information according to Annex E and F that are used to prepare the risk profiles and risk management evaluations can serve as a guidance for the survey. These forms are found in the Handbook for Effective Participation in the Work of the POPs Review Committee and on the POPRC website (www.pops.int/poprc).

b) Chemical profiles

244. Information collected through a multistakeholder committee or national surveys can be compiled to create a chemical profile that is an evaluation of the current situation of each of the new POPs. This profile can then be one of the main inputs for the NIP update. Such an evaluation could include the following information:

- Type of use(s) and name of commercial products
- Production data (quantity and location)
- Import and export data (quantity)
- Main producers and importers
- Main regulations
- Releases to the environment (e.g. inventories)
- Monitoring and exposure data
- Review of local scientific studies on adverse effects
- Available alternatives

Chapter 4. ALTERNATIVES AND SUBSTITUTES

245. At its fourth meeting in May 2009, the Conference of the Parties reviewed the recommendations of the Persistent Organic Pollutants Review Committee and agreed to list the proposed substances in Annexes A, B and C of the Convention. Chlordecone, hexabromobiphenyl (HBB), hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE), tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE), lindane, pentachlorobenzene (PeCB), alpha hexachlorocyclohexane (alpha-HCH) and beta hexachlorocyclohexane (beta-HCH) were listed in Annex A, which means that the use and production of these substances will have to cease, except for specific exemptions mentioned in the Annex. Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride were included in Annex B, which allows Parties to continue to produce or use them for acceptable purposes and specific exemptions. Since PeCB can be produced as an unintentional by-product, it was also listed in Annex C, which means that its releases have to be minimized or eliminated.⁸

246. As indicated in chapter 1 of this guidance document, the production and use of chlordecone, HBB, hexaBDE and heptaBDE is believed to have ceased, though it is possible that they continue to be produced or used in some developing countries. While PeCB, tetra- and pentaBDE and perfluorooctane sulfonate (PFOS) have been restricted or prohibited in some countries, due to their diverse uses, they are still produced and used in many countries. Alpha-HCH and beta-HCH are no longer produced intentionally but mostly as a by-product of the production of lindane.

247. In this context, Parties that are still producing or using the new POPs listed in Annex A have to search for and identify alternatives to replace them. In the case of PFOS, the specific exemptions and acceptable uses allowed by the Convention will eventually be removed; Parties are therefore encouraged to find alternatives to these chemicals.

248. The POPs Review Committee has developed “Guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals” (UNEP/POPS/POPRC.5/10/Add.1). This document provides general guidance on the identification and evaluation of alternatives to the chemicals listed in the annexes to the Stockholm Convention or proposed for listing in the annexes and is available on the Stockholm Convention website (www.pops.int). The present chapter contains a summary of the information presented in this guidance document. In addition, the POPs Review Committee has developed specific guidance for two of the new POPs:

- Guidance on feasible flame-retardant alternatives to commercial pentabromodiphenyl ether (UNEP/POPS/COP.4/INF/24)
- Guidance document on alternatives to perfluorooctane sulfonate and its derivatives (UNEP/POPS/POPRC.6/13/Add.3)

249. Given that some Parties have already phased out the use of some of the new POPs, alternative chemicals, products or process to substitute them are already in use. Table 3.1 shows the available alternatives for new POPs included in the risk profiles and risk management evaluations prepared by the POPRC², as well as the guidance documents mentioned above.

Table 4.1 Alternatives identified for the new POPs

Chemical	Alternatives	
	Name	Use
Chlordecone	Ethoprop, oxamyl	Pesticide to control banana root borer
	Cyfluthrin, Imidacloprid	Pesticide to control tobacco wireworms
	Azadirachtin, bifenthrin, boric acid, carbaryl, capsaicin, cypermethrin, cyfluthrin, deltamethrin, diazinon, dichlorvos, esfenvalerate, imidacloprid, lambda-cyhalothrin, malathion, permethrin, piperonyl butoxide, pyrethrins, pyriproxyfen, resmethrin, s-bioallethrin, tetramethrin <i>Bacillus thuringiensis</i> ; cultural practices such as crop rotation, intercropping, and trap cropping; barrier methods, such as screens and bagging of fruit; use of traps such as pheromone and light traps to attract and kill insects.	Pesticide to control ants and/or cockroaches Pest management

⁸See the report of the meeting <http://chm.pops.int/>

²<http://chm.pops.int/tabid/243/language/en-US/Default.aspx>



Chemical	Alternatives	
	Name	Use
Hexabromobiphenyl	Tris-chloropropyl-phosphate (TCPP), tris-chloroethyl-phosphate, tris dichloropropyl phosphate (TDCPP), tetrabromobisphenol, triphenyl phosphate (TPP), tricresyl phosphate (TCP), resorcinol bis(diphenylphosphate) (RDP), and phosphonic acid (2-((hydroxymethyl) carbamyl)ethyl)-dimethyl ester (Pyrovatex®)	ABS plastics
	Aluminium trihydroxide, magnesium hydroxide and zinc borate	Coatings and lacquers
	Ammonium polyphosphate (APP) is commonly used in combination with Aluminium hydroxide and Melamine; red phosphorus; polyglycol esters of methyl phosphoric acid; amino-methyl phosphonic acid are other altern	Polyurethane foams
Lindane	Permethrin; Bioallethrin and piperonyl butoxide; Pyrethrin and piperonyl butoxide; Pyrethrum and piperonyl butoxide; Precipitated disulphur 6% in petrolatum and Crothamiton 10% (Eurax); malathion; Flumethrin; Cypermethrin; Cabaryl; Stemon root extract and benzyl benzoate and Disulfiram with bezybenzoate.	Pharmaceutical uses
	Clothianidin, Thiamethoxam, Imidacloprid, Permethrin, Tefluthrin, Acetamiprid and Fipronil	Seed treatment
Tetrabromodiphenyl ether and pentabromodiphenyl ether	Aluminium hydroxide (ATH), magnesium hydroxide, ammonium poly phosphate, red phosphorus, zinc hydroxystannate (ZHS), zinc stannate (ZS) & ZHS/ZS-coated ATH	Epoxy resins
	Metallic phosphinates, reactive nitrogen and phosphorus constituents (unspecified), DOPO9	
	Tetrabromobisphenol A (reactive), ethylenebis (tetrabromo), phthalimid	
	Alternative flame retardant materials: Polyethylene sulphide	
	Aluminium hydroxide (ATH), zinc borate, zinc-molybdenum compounds (together with phosphate esters), zinc hydroxystannate (ZHS), zinc stannate (ZS) & ZHS/ZS-coated ATH	Polyvinylchloride (PVC)
	Tricresyl phosphate (also plasticizer)	
	Tris (dichloropropyl) phosphate, Vinylbromide	
	Alternative flame retardant materials: Rigid PVC is flame inherent itself	
	Melamine, tris (1,3-dichloro-2-propyl) phosphate (TDCPP) (or TCPP) and ammonium polyphosphate (APP)	PUR foam
	Dimethyl propyl phosphonate (DMPP), reofos (non-halogen flame retardant)	
	Bromoalkyl phosphates, tetrabromophthalic anhydride, tris(chloroethyl) phosphate (TCPP) (together with brominated polyols or red phosphorus)	
	Alternative flame retardant materials: intumescent systems	
	Non chemical alternatives identified include barrier technologies; graphite impregnated foam and surface treatment	

Chemical	Alternatives	
	Name	Use
	Ammonium polyphosphate, aluminium hydroxide (ATH), magnesium hydroxide, zinc hydroxystannate (ZHS), zinc stannate (ZS) & ZHS/ZS-coated ATH Triethyl Phosphate, dimethyl propyl phosphonate (DMPP) Dibromostyrene, tetrabromophthalic anhydride based diol, tetrabromophthalic anhydride, bis (tribromophenoxy) ethane Alternative flame retardant materials: intumescent systems	Unsaturated (Thermoset) polyesters (UPE)
	Alkyl diaryl phosphates (nitril rubber) Alternative flame retardant materials: intumescent systems	Rubber
	Triaryl phosphates (unspecified), Tetrabromo phthalate diol, tetrabromophthalic anhydride based diol, bis (tribromophenoxy) ethane Alternative flame retardant materials: intumescent systems, silicone rubber	Paints/lacquers
	Bromine-free circuit boards, phosphorus-based flame retardants for printed circuit boards, flame resistant plastic, halogen-free materials, low-voltage internal wires, zinc borate, magnesium hydroxide or expandable graphite	Electronic equipment-appliances
	Aluminium hydroxide, magnesium hydroxide, ammonium compounds (unspecified), borax Tetrakis hydroxymethyl phosphonium salts such as chloride (THCP) or ammonium (THPX), dimethyl phosphono (N-methylol) propionamide, diguanidine hydrogen phosphate, aromatic phosphates (unspecified), dimethyl hydrogen phosphite (DMHP), melamine (nitrogen based), phosphor nitrilic chloride (PNC) Trichloropropyl phosphate Alternative flame retardant materials: intumescent systems, aramide fibres (certain protective applications), wool, modacrylic	Textiles
	Butylated triphenyl phosphate esters	Hydraulic oils
	Other fluorinated compounds, like C6-fluorotelomers and PFBS, silicone-based products, stearamidomethyl pyridine chloride	Textile impregnation and surface protection
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride	Fluorotelomer-based substances and phosphates, mechanical processes	Impregnation of paper and cardboard
	Fluorotelomer-based substances, fluorinated polyethers, C4-perfluorinated compounds	Cleaning agents, waxes and polishes for cars and floors
	Telomer-based compounds, fluorinated polyethers, PFBS, propylated aromatics, silicone surfactants, sulfosuccinates, polypropylene glycol ethers	Surface coatings, paint and varnish
	PFBS, telomer-based fluorosurfactants, perfluoroalkyl-substituted amines, acids, amino acids and thioether acids	Oil production and mining
	Telomer-based surfactants products, hydrocarbon surfactants, silicone products, C3-C4-fluorinated chemicals	Photographic industry
	For most of these uses, alternatives are available or are under development.	Electrical and electronic parts



Chemical	Alternatives	
	Name	Use
	No substitutes with comparable effectiveness have been identified, and doing so may take up to 5 years, according to the industry. It should be possible to use PFBS, fluorinated polyethers or telomers.	Semiconductor industry
	Other fluorinated substances and phosphate compounds could be used.	Aviation hydraulic oils
	Synthetic piperonyl compounds such as S-Methoprene, Pyriproxyfen, Fipronil and Chlorpyrifos are alternative active substances, sometimes used in combination. Alternative surfactants may exist.	Pesticides
	Repairing such video endoscopes requires a CCD colour filter containing PFOS. New CCD filters are PFOS-free. For radioopaque ethylene tetrafluoroethylene, PFBS can replace PFOS.	Medical devices
	Some non-fluorinated alternatives are marketed but they are not considered equally effective in hard chrome plating. A C6-fluortelomer is used as a substitute and may be effective. PFBS derivatives may also be used. Physical barriers may also be applied.	Metal plating
	C6- fluorotelomers are used as substitutes in new products; fluorine-free alternatives are used for training exercises and possible possibly in other settings than offshore.	Fire fighting foam
Hexabromodiphenyl ether and heptabromodiphenyl ether	Tetrabromobisphenol-A, 1,2-bis(pentabromophenoxy) ethane, 1,2-bis(tribromophenoxy) ethane, triphenyl phosphate, resorcinol bis (diphenylphosphate) and brominated polystyrene	For ABS plastic
	Reactive phosphorous constituents such as polyglycol esters of methyl phosphonic acid and hexabromocyclododecane	Synthetic textiles
	Bis (tribromophenoxy) ethane and tribromophenyl allyl ether	Thermoplastic elastomers
	Polypropylene-dibromostyrene, dibromostyrene, and tetrabromobisphenol A (TBBPA)	Polyolefins
Pentachlorobenzene	There is no current commercial demand for PeCB, no alternatives have been identified or developed. For the production of quintozone, an alternative process using the chlorination of nitrobenzene is available.	
Alpha hexachlorocyclohexane	These chemicals are by-products in the manufacture of lindane. No alternatives have been identified.	
Beta hexachlorocyclohexane		

4.1 Identification and evaluation of alternatives

250. Figure 4.1 below shows a process Parties can take to identify and evaluate alternatives.

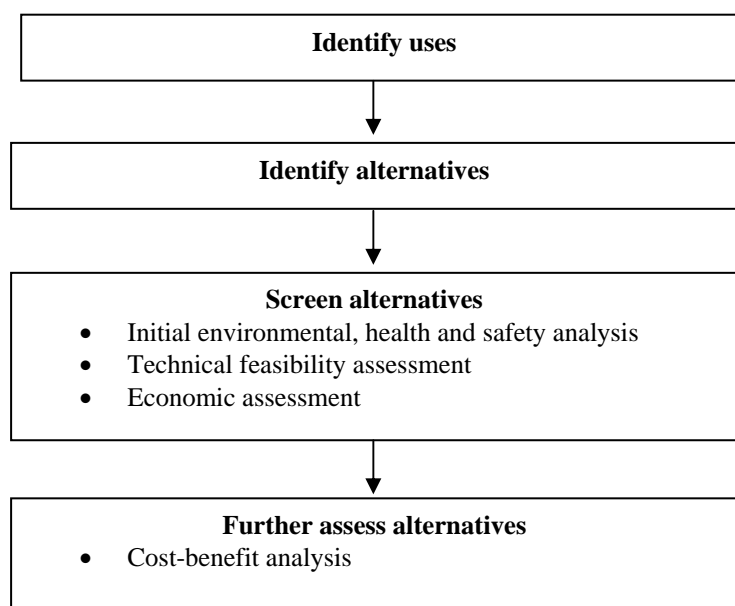


Figure 4.1. Steps to identify and evaluate alternatives.

Step 1. Identify uses

251. The first step consists of identifying the use of the chemical to be replaced and information related to the current situation of the chemical at the national level. The information should be as complete as possible including the following elements:

- Production and import of the concerned substances and products that contain these substances
- Ways in which the concerned substances and products containing them are used in industrial processes or other practices, including the required functions and features of the substances that make the use of the substances necessary (including technical, economic and social considerations)
- Potential emission into the environment (including the waste and recycling stages in their life-cycle)
- Major suppliers of the chemical
- Major derivatives, components and/or end products that incorporate the chemical or use the chemical as a feedstock, and their manufacturers
- Major distributors, retailers, or customers of end products
- Functionality requirements of the chemical, component or end-product (for example, why is the chemical used and what is it used for?)
- Relevant stakeholders, including businesses, industry associations, environmental, public health, and labour organizations (TURI, 2006)

252. The information sources identified in chapter 2, and the recommendations to fill information gaps in section 2.3, can help Parties obtain these data.

Step 2. Identify alternatives

253. The next stage is the identification of alternatives. For this it is necessary to list potential alternatives that can achieve the equivalent function of the substance of concern. Alternatives can include:

- Changes to manufacturing process: The aim here is to switch to cleaner technologies that are less polluting.
- Material substitutes: This can be a direct substitute to the new POP or a change in the raw materials used in the process.
- Changes to component/product design: A change in the product can eliminate the need for the new POP of concern.
- Non-chemical alternatives: Measures that do not rely on the use of chemicals, such as alternative industrial processes and innovative practices, are also included among potential alternatives.



254. In this phase, consultation with experts and stakeholders (such as trade associations, manufacturers, other government authorities, scientific researchers and end-users) is essential. Table 4.1 can serve as a start to the identification of potential alternatives.

Step 3. Screen alternatives

255. When considering the application of an alternative, the availability, technical feasibility, accessibility and efficacy of the potential alternative should be assessed.

- **Technical feasibility:** Practicability of applying an alternative technology that currently exists or is expected to be developed in the foreseeable future.
- **Efficacy:** How well an alternative performs, including any potential limitations.
- **Availability:** The extent to which an alternative is on the market or is ready for immediate use.
- **Accessibility:** The ease with which an alternative can be obtained and used, given geographic, legal or other limitations.

a) Initial environmental, health and safety analysis

256. It is advisable to carry out an initial screening to determine if the alternatives identified are not persistent, bioaccumulative and toxic and/or if they reduce the potential for harm to human health. This phase will be a first filter to eliminate alternatives for further consideration. At this stage, the screening is applied only to the substances present in the alternative formulation or product, not to feedstock materials upstream, or breakdown products downstream (TURI, 2006).

b) Technical feasibility assessment

257. The goal of the technical feasibility assessment is the selection of technologies or processes, which meet the necessary technical requirements. Parameters reviewed include the following (TURI, 2006):

- Longevity, (i.e. the useful life of the component/end-product)
- Key performance requirements for the application, such as power requirements, accuracy, noise level, operating temperature
- Key physical characteristics (for example, density, colour or weight)
- Key quality parameters (for example, time needed for maintenance or repair, or mean time between failures)

c) Economic feasibility assessment

258. The use of alternative products and processes may lead to human health and environmental benefits but can also result in additional costs. Therefore the economic feasibility of alternatives needs to be considered by making estimates of these additional costs.

259. Economic factors are strongly affected by both current and future market structures, so there can be a lot of uncertainty about future projections. Market conditions such as behaviour of consumers, supplier, supply, demand, competitors and distribution channels can be very versatile. The following items should be considered when doing the economic assessment:

- Initial purchase price for the chemical/alternative
- Initial purchase cost for the end-product/component
- Availability of the component/end-product
- Capital costs, such as the cost of installation of new equipment
- Overall manufacturing costs for the component/end-product, including energy consumption and maintenance costs
- Operating costs during the use of the end-product, including energy consumption and maintenance costs
- Replacement rate, which is related to the useful life of the product
- End-of-product life costs, such as cost of disposal
- Other costs such as employee and consumer training costs, safety costs, insurance costs, taxes or fees (TURI, 2006)

260. A comprehensive approach to social and economic assessments is contained in the guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals.

Step 4. Further assess alternatives

a) Assessment of risks

261. Since the primary objective of substitution is to reduce the risk to human health and the environment, it is important to ensure that the alternative does not result in an equivalent or greater risk or in a shift of the problem to another area (for example from air to water). Once technically feasible alternatives are identified, a risk assessment needs to be carried out. The risk assessment looks at both the potential hazard of the alternative and the extent of exposure to this hazard by workers, consumers, the community and the environment. When reviewing the properties of the alternative, these should be compared to the POPs criteria to prevent the replacement of one POP by another substance with similar characteristics. The resources listed in Chapter 3 can assist in finding the information needed to do this assessment. When considered necessary, Parties can also make use of existing risk assessment studies and apply those as appropriate to the national context. Further considerations on risk assessments are described in the guidance on considerations related to alternatives and substitutes for listed persistent organic pollutants and candidate chemicals.

b) Cost-benefit analysis

262. In this phase a comparison between costs and benefits of the use of the alternative is made. The extra costs involved in changing to a less risky alternative are compared to the health and environmental benefits that will be achieved. When doing this comparison and making a decision about the overall benefits of an alternative, it is important to remember that the technological costs of adopting an alternative are often more easily and more accurately estimated than benefits to human health and the environment.

263. Potential costs of switching to an alternative solution include costs to the manufacturer and to the user, for example in terms of additional production costs for manufacturers (e.g. higher raw material prices or investment in changes to the manufacturing processes), higher price of the alternative to users or lower performance of the alternative.

264. The potential costs are then compared with the following benefits:

- A lower risk of injury to people and/or the environment
- Reduced need for safety measures (protective measures) including special precautions during production, use, transportation and waste management
- Increased technical performance of the alternative
- A reduction in the quantity of hazardous waste generated (SFT, 2007a) and the clean-up for contaminated sites

265. If the assessment indicates that the alternative has overall lower costs or that the benefits outweigh the costs, this would be considered an appropriate choice to replace the new POP. If the assessment does not identify a suitable or practical alternative, the Party may need to request for a specific exemption or notify the Secretariat that it will make use of the acceptable purpose.

c) Promoting development and use of safer alternatives

266. The following strategies have been used to promote the development and use of safer alternatives:

- **Adopting the substitution principle as part of the national chemicals management policy:** The inclusion of this principle can be supported with incentives to stimulate research and the market for safer substitutes.
- **Green procurement:** Green procurement guidelines used by large consumers, such as governments, hospitals, or manufacturers that require the purchase and use of safer chemicals and materials provide a market incentive for the adoption of alternatives to toxic chemicals.
- **Financial incentives:** A levy charge on the use or release of hazardous chemicals or tax rebates for companies that comply with voluntary measures provide a greater economic advantage for the use of non- or less hazardous products.
- **Raising awareness:** Tools that raise awareness of consumers can help change purchasing choices for safer alternatives, and thus increase market demand for alternatives. This can be done through the adoption of classification and labelling systems (for example ecolabelling) for chemical products that integrate health and environmental criteria and an obligation to inform customers and consumers. Education campaigns aimed at consumers and other users that provide information on chemicals of high concern, the products in which they are found and the alternatives to these products can also assist in changing purchasing behaviours.
- **Promote and invest in green chemistry:** Green chemistry integrates environmental and health considerations at the outset of new chemical synthesis to ensure new chemicals are inherently safe.
- **Research and development** in alternatives and methods to reduce the use of toxic chemicals and products can strengthen industrial competitiveness while reducing risks to workers, the community and the environment. (Thorpe, 2005; Commission of the European Communities, 2003; Greenpeace, 2003).

4.2 Case studies



267. The substitution of chemicals or processes with less hazardous alternatives is considered an effective strategy to reduce risks to human health and the environment. This strategy is taking major relevance worldwide considering the international initiatives that have adopted it to comply with their objectives to protect human health and the environment from chemicals use (i.e. the Strategic Approach to International Chemicals Management (SAICM) and the Stockholm Convention). There are many case studies that corroborate the feasibility of substitution and the usefulness of methodologies established to identify and evaluate alternatives, which are similar to the one proposed in this chapter.

268. A significant and successful case study was the elimination of use of DDT for malaria control in Mexico. Efforts focused primarily on deploying alternative methods of controlling mosquitoes, which implied the evaluation and testing of alternatives to DDT, including biological controls; strengthening public health measures to ensure early detection and immediate treatment for those exposed to malaria; public education, with an emphasis on the health and environmental effects of DDT; and information on community hygiene practices to reduce habitat and breeding sites of insects that transmit malaria. The support of the United States and Canada through the Commission for Environmental Cooperation of North America was a key aspect for the successful substitution of DDT. Mexico stopped using DDT in 2000. This experience was shared with countries of Central America, in which demonstrative projects were carried out to showcase malaria control without the use of DDT (CEC, 2003).

269. In the following subsections additional case studies of substitution of POPs are described that illustrate that the substitution of POPs is a feasible task, both technically and economically; however, it is important to note that the complete replacement of industrial chemicals can be more complicated due to their multiple uses (such as precursors, an intermediate in production processes, a product contained in an article, etc.) and the fact that they can be complex mixtures. Therefore, the research for alternatives for an industrial chemical is likely to be more difficult than for a pesticide. A close cooperation with the industrial sector as well as the scientific community to identify best alternative options is required.

4.2.1 Lindane⁹

270. In the eighties and nineties, the member states of the European Union replaced lindane and pentachlorophenol (PCP) for use by private consumers with pyrethroids and dichlofluanid respectively. The persistence and contamination of PCP and lindane with dioxins resulted in a high concern among consumers and a reluctance to use such products in their private environment. Strict regulations led to a strong decline of the use of PCP and lindane. While the substitutes are not free of hazards, those products are considered safer from a health and environmental aspect.

271. Several factors influenced the switch to alternative products: PCP and lindane were subject to a number of public scandals in the seventies and eighties. Accidents during production and use, the ubiquitous detection of these two chemicals in soil, food and human tissues and especially the dioxin content made them “prominent” as dangerous chemicals. In addition, both PCP and lindane were the subject of many environmental campaigns. The awareness among consumers of wood treatment products was comparably high and the fact that these chemicals remain for a long period in the household and the private environment increased the concern over their use. The scientific findings about the persistence and the contamination of PCP and lindane with dioxins resulted in a high sensitivity and resistance among consumers to use such products in their private environment. This in turn resulted in stricter regulations that reduced the use of PCP and lindane to a minimum in consumer products.

272. Producers reacted to consumers’ wishes for less toxic products, and started to market PCP- and lindane-free products. Another factor that made the change easier was the fact that substitution of a biocide by another implied no change in handling and application.

4.2.2 Brominated flame retardants¹⁰

273. Brominated flame retardants (BFRs) are used in a wide range of consumer products including electronic components, textiles, foam in upholstery, carpets and buildings. By the late 1980s, as evidence of the dangers of brominated flame retardants, particularly PBBs and PBDEs, grew, Germany, Denmark, the Netherlands and Sweden began restricting and banning their use.

274. The electronics company NEC produces mobile phones, office equipment and personal computers. Its environmental policy includes a target to stop the use of halogenated flame retardants by 2011. In 1999, the company launched a silicone-based polycarbonate containing flame retardant which it claims to be ‘far superior to conventional flame-retarding plastics in environmental safety’. Sold under the brand name NuCycle, the new material is used in NEC’s liquid crystal display (LCD) monitors and battery packs for portable computers. It also can be recycled and used for the same purpose up to five times.

⁹ Commission of the European Communities (2003) Substitution of hazardous chemicals in products and processes. Directorate General Environment, Nuclear Safety and Civil Protection of the Commission of the European Communities. http://ec.europa.eu/environment/chemicals/pdf/substitution_chemicals.pdf Last consulted October, 2009.

¹⁰ Greenpeace (2003) Safer chemicals within REACH.

<http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/6031.pdf> Last consulted October, 2009.

275. In 2000, NEC developed an epoxy resin, which it describes as a fire-retardant structure, that avoids the need for either tetrabromobisphenol A or phosphorus-based flame retardants in circuit boards. The new resin contains a metal hydroxide retardant. The company claims the new board is ‘almost totally free of pollutants’, and is easy to process and recycle thermally. By integrating flame retardant properties within the board, use of the metal hydroxide is minimized. This change in design also resulted in good electrical properties, higher heat resistance and improved processing characteristics.

276. In addition, other companies such as Apple, Sony, Samsung, National/Panasonic (Matsushita), Siemens, IKEA, Marks & Spencer, H&M and Skanska, have been taken measures to eliminate brominated flame retardants from their products.

277. Substituting BFRs using alternative chemicals is only one route to addressing fire risks: material and functional alternatives as well as preventive action that reduces the need for flame retardants can be used. Some companies have gone down the non-chemical solution route (for example IKEA and Sony’s use of non-flammable materials).

278. In the experience described above, substitution fell into the following basic types:

- Using non-flammable materials: Substituting flammable with non-flammable materials (for example using ceramic instead of plastic in circuit boards) can make the use of flame retardants unnecessary.
- Preventing the risk of fire by improving design: for example by increasing the distances between possible flashpoints and flammable materials.
- Replacement: Substituting hazardous flame retardants with ones that have a smaller impact on the environment and human health.

4.2.3 Polychlorinated biphenyls¹¹

279. The use of polychlorinated biphenyls (PCBs) in Sweden has been restricted since 1972 and in 1978 the authorities decided that no permits to use PCBs in new products should be issued. Once the regulations and restrictions were adopted the industry phased out PCBs swiftly. PCBs were mainly used as insulating fluid in transformers and capacitors because of their thermal and electrical properties. Chemical alternatives most frequently used as transformer fluids are mineral and silicone oils. Mineral oils with different additives are the main alternative. Silicone oils are used in network and building transformers where fire hazards are of special concern. The properties of PCBs that are difficult to match using alternatives are their thermal and hydrolytic stability combined with their lack of polarity. The capacitor fluids most frequently used in Sweden are dodecylbenzene and a mixture of methyl(phenylmethyl)benzene and methylbis(phenylmethyl)benzene.

280. In Sweden the transfer to new chemical products and technical solutions was accomplished without too many obstacles in most sectors of the industry. In spite the fact that the chemical and technical properties of PCBs are to a certain extent unique, the availability of chemical and technical alternatives facilitated the substitution. The main cost factor implied by the change was the destruction of PCB liquids and materials contaminated by PCBs.

¹¹ Öberg T (1996) Replacement of PCBs (polychlorinated biphenyls) and HCB (hexachlorobenzene) – the Swedish experience. <http://tomasoberg.com/pdf/pcb.pdf> Last consulted October, 2009.



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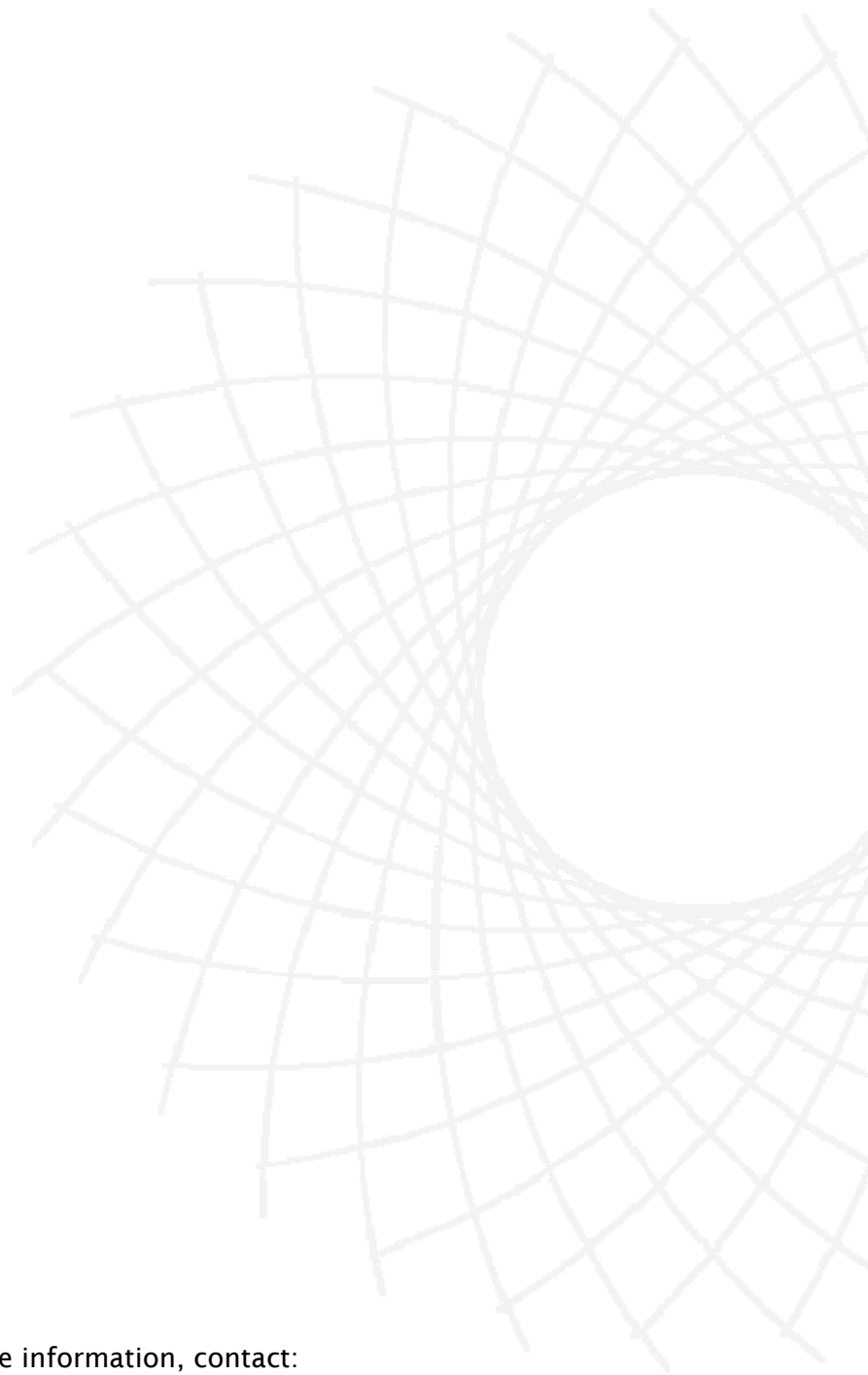
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