Diagnosis of the New POPs in the Mediterranean countries

Regional Activity Centre for Cleaner Production (CP/RAC)
Mediterranean Action Plan

Regional Activity Centre
for Cleaner Production

UNEP

MAP

STOCKHOLM
CONVENTION

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

Generalitat de Catalunya
Government of Catalonia
Department of the Environment and Housing

If there is any study point which can be improved or if there is any inaccuracy, please let us know.

The CP/RAC, based in Barcelona-Spain, was established in 1996. Its mission is to promote mechanisms leading to sustainable consumption and production patterns and sound chemicals management in Mediterranean countries. The CP/RAC activities are financed by the Spanish Government once they have been submitted and approved by the Contracting Parties to the Barcelona Convention and by the Bilateral Monitoring Commission made up of representatives from the Spanish and Catalan Governments.

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0. Executive Summary

Introduction

The Regional Activity Centre for Cleaner Production (CP/RAC) is one of the six Regional Activity Centres (RAC) of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme and a Regional Centre under the Stockholm Convention on Persistent Organic Pollutants (POPs) for capacity building and transfer of technology in the Mediterranean Region.

The Conference of the Parties of the Stockholm Convention, at the fourth meeting of the Parties, considered the recommendation of the POPs Review Committee (POPRC) and decided on listing nine new chemicals under Annex A, B or C.

One of the challenges of the CP/RAC is to promote among the Mediterranean Countries the incorporation of the new POPs in the local and regional legal measures and strategies, and in the National Implementation Plans of Stockholm Convention. In this framework, the CP/RAC has prepared this diagnosis of the new POPs in the Mediterranean Region as part as its work programme.

Furthermore, the 16th Meeting of the Contracting Parties of the Barcelona Convention, urges the Contracting Parties to agree to start working with the support of MEDPOL and CP/RAC with a view to preparing Regional Plans/Programmes pursuant to Article 15 of the LBS Protocol, on the new POPs included in the Stockholm Convention. The present assessment will be considered as the basis for the development of the Regional Plan on the new POPs, to be submitted to the Conference of the Parties of the Barcelona Convention in its 17th Meeting.

Objectives and scope

The main **objective** of this study is to assess the current situation on the production, uses, consumption and waste management of the new chemicals listed in the annexes of the Stockholm Convention. Furthermore, the report comprises an analysis of the existent alternatives in the market to those substances, and the degree of substitution achieved. Finally, a set of guidelines and proposals of actions for the Mediterranean countries to adjust to the new requisites of the Convention and to adapt their National Implementation Plans is provided.

The **scope** of this report covers the 21 countries of the Mediterranean Action Plan (Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey), and the nine new chemicals listed to the annexes of the Convention, with its exemptions, as shown in the following table:

Chemical	Listed in Annex	Acceptable purpose or specific exemption
Alpha-hexachlorocyclohexane (α-HCH)	A	None
Beta-hexachlorocyclohexane (β-HCH)	A	None
Chlordecone	A	None
Hexabromobiphenyl (HBB)	A	None
Hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE)	A	Use of recycled articles containing this substance
Lindane (γ-HCH)	A	Pharmaceutical use
Pentachlorobenzene (PeCB)	A & C	None
Perfluorooctane sulfonic acid (PFOS) and its salts	B	Production for specific uses and uses for acceptable purposes
Perfluoroctane sulfonyl fluoride (PFOS-F)	B	Production for specific uses and uses for acceptable purposes
Tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE)	A	Use of recycled articles containing this substance

Source: UNEP, 2009a.

It should be noticed that tetra-BDE and penta-BDE are the main components of the commercial pentabromodiphenylether (c-pentaBDE), and hexaBDE and heptaBDE are the main components of the commercial octabromodiphenylether (c-octaBDE). Hence, these two products are indirectly included in the analysis.

International framework

Several international agreements tackle the issue of chemicals and their impact to the environment and human health. Some of these agreements affect the MAP Countries and include the new POPs listed to the Stockholm Convention.

The study includes a brief description of the main aspects of the following Conventions and synergies among some of them:

- The MAP, the Barcelona Convention and the MED POL.
- The Stockholm Convention
- Rotterdam Convention

- Basel Convention
- Strategic Approach to International Chemicals Management (SAICM)
- Convention on Long-range Transboundary Air Pollution
- OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic

Available information and previous studies on the new POPs

The information has been compiled in the following tables[1].

α-HCH and β-HCH	
Main characteristics	Both compounds have demonstrated to have properties favourable to long range transportation through environmental compartments, persistence in the environment, bioaccumulation and toxicological effects (neurological, hepatological, reproductive, immunosuppressive and carcinogenic).
Production and uses	Alpha-HCH and beta-HCH are not intentionally produced for commercial uses, and they do not occur as a natural substance. They are a by-product from the manufacturing of technical HCH, used as organochlorine insecticide or chemical intermediate to manufacture gamma-HCH (Lindane). Currently, there is no production of technical HCH, although manufacture of Lindane might still occur which could lead to the existence of stocks of α-HCH and β-HCH as wastes, since the production of one ton lindane generates up to eight tons alpha- and beta-HCH.
Releases to the environment	Most common source has been releases into atmosphere form technical-HCH manufacturing facilities. It is estimated that of 4.3 million tones of alpha-HCH and 230,000 tones of beta-HCH have been emitted into the atmosphere (UNEP, 2007a). Emissions of these substances started to increase after the 1940s, with a peak in the early 1970s, when the figures started to drop because of the prohibition on the use in some regions. Releases are also possible from hazardous waste sites, stockpiles and residues of lindane from former production sites.
Status under international regulation	In addition to the Stockholm Convention, regulated under the Aarhus Protocol on POPs to the LRTAP Convention and the OSPAR Commission. Production and use restricted in the European Union through several legal texts.

[1] The information provided these section's tables has been compiled from several documents, so the source is not always displayed.

Chlordecone	
Main characteristics	This substance is highly persistent in the environment, since it does not hydrolyse or biodegrade, photodegrade or volatilise. Several studies show high bioaccumulation and biomagnification potential. It is acutely and chronically toxic, producing neurotoxicity, immunotoxicity, reproductive, musculoskeletal, liver toxicity and it is possibly carcinogen for humans. Information on long range transportation is not conclusive, but according its properties it is possible to occur.
Production and uses	Production started in early 1950s in USA where it ended in 1975 (ATSDR, 1995). 90-99% of the total volume of Chlordecone produced during this time was exported to Europe, Asia, Latin America, and Africa (UNEP, 2007g). It was used primarily as insecticide for several crops, and in household products. Also used as fungicide. Production and use of chlordecone has been reported to have ceased over the last decades in developed countries, but it can still be produced or used as an agricultural pesticide in some developing countries.
Releases to the environment	It is assumed that all produced amounts have been finally released to the environment through direct applications to crops. Severe contamination of soil and surface water has been reported, and are currently being monitored. In the pesticide application, major releases of chlordecone occurred to the air, surface waters due to particles runoff with rains, and groundwater contamination through percolation. Chlordecone is also a contaminant in mirex formulations so it is expected to occur in the degradation processes of mirex stockpiles.
Status under international regulation	Regulated under Protocol on POPs to the LRTAP Convention, OSPAR Convention and HELCOM Convention. Basel Convention makes no reference to chlordecone, but it includes mirex, a very similar compound. Not listed in Rotterdam Convention but it might be included in the near future. Banned for import, production or use in several countries.

Hexabromobiphenyl	
Main characteristics	PBBs family of compounds (including HBB) has been proved to be persistent under field conditions, but partially degradable in soil to similar compounds. It shows high bioaccumulation capacity and bioconcentration along the food chain, and long range transportation has been proved. It is considered as possible human carcinogen, and it is proved to affect the endocrine system.
Production and uses	Production began in 1970 and over 98% was produced as FireMaster BP-6. The sole production of this substance in the USA stopped the production of HBB in 1975 after an agriculture contamination episode (US ATSDR, 2004; UNEP, 2007i). Production of HBB has ceased in most countries, but it is possible that it is still produced in some developing countries but in countries with economies in transition. It was primarily used as fire retardant in plastics, electric components and polyurethane foam for auto upholstery.

Hexabromobiphenyl	
Releases to the environment	The most common pathways were: to air during production, solid losses to landfill from drying, handling, shipping and transportation, to soil in bagging and loading areas, and to waste water from the quenching and washing of the PBBs. Releases can also arise from the widespread used as flame retardant, and it is expected that these releases carry on for long periods, due to the high stability of this substance.
Status under international regulation	Regulated under Protocol on POPs to the LRTAP Convention, OSPAR Convention, Basel Convention, Rotterdam Convention and HELCOM Convention. Production and use restricted in the European Union through several legal texts. National restrictions in several countries outside the EU.

HexaBDE and heptaBDE (C-octaBDE)	
Main characteristics	The family of PBDEs has been proved to be very persistent in the environment. The only identified degradation pathway is photolysis, anaerobic degradation and metabolism in biota through debromination producing lower bromine congeners which might have higher toxicity and bioaccumulation potential. It has been found in remote areas, proving its long range transport potential. Information on toxicity and ecotoxicity is very limited.
Production and uses	Data from 1999 mentioned 9 producers worldwide, one of them in France, but in 2003 none of the EU sites reported production of this substance. C-octaBDE is mainly used as additive fire retardant in plastic and textile industries. Other uses that have been reported include nylon and low density polyethylene, polycarbonate, phenol-formaldehyde resins and unsaturated polyesters and in adhesives and coatings.
Releases to the environment	Releases to the environment have been reported to occur during the whole life cycle of the product, from manufacture to containing-article utilization. During the production, releases occur to wastewater and to air in form of dust, but it is expected that the dust will rapidly settle so losses will be mainly to solid waste, which may be recycled or disposed of, or washed to wastewater. During the service life of the product containing c-octaBDE, losses might occur through volatilisation.
Status under international regulation	Hexa- and heptaBDE have been recently included in the POPs protocol of the LRTAP Convention. They are also regulated by the OSPAR Commission, HELCOM Commission, and OECD Member countries agreed to oversee a voluntary industry commitment by the global manufacturers of brominated flame retardants to take certain risk management actions on these substances.

Lindane	
Main characteristics	Lindane has persistent, bioaccumulative and toxic properties. It has been found in samples around the world, especially in Artic communities, demonstrating its capacity for long range transportation. At high doses, can be neurotoxic, hepatoxic, immunotoxic and it has negative reproductive effects in laboratory animals. In addition, it has carcinogenic effects in humans.

Lindane	
Production and uses	The manufacturing reaction of lindane (γ-HCH) has a low yield, so for each ton this isomer produced, 6 to 10 tons of the other isomers were obtained as wastes. Estimations are of 600,000 tons used worldwide from 1950 to 2000 (IHPA, 2006). It has been used on a wide variety of crops, seed treatment, tree and wood treatment and against ectoparasites in both veterinary and human applications.
Releases to the environment	Releases to air have occurred due to agricultural application or from volatilization of the substance or particulates of contaminated soils caused by erosion. Releases to surface water can occur via runoff or through wet deposition of particles in the atmosphere. It can reach groundwater via soil leachate although it has low mobility in soils.
Status under international regulation	It is regulated by the COPs Protocol of the LRTAP Convention, Rotterdam Convention, OSPAR Commission and the North America Regional Action Plan. At a European level, several legal texts include restrictions on the use of this substance, and from 2007 is banned for production, use or recycling operations.

Pentachlorobenzene	
Main characteristics	Pentachlorobenzene bioaccumulates in the food chain, is persistent in the environment and toxic to organisms, and has been proved to travel long distances through environmental compartments.
Production and uses	In the past, pentachlorobenzene was used in transformers' dielectric fluids in combination with PCBs, in dyestuff carriers, and as a flame retardant. The main current use of this substance is as a chemical intermediate in the manufacture of quintozene (a fungicide), so PeCB can occur as an impurity. The available data suggest that substitutes to PeCB have been found, and that the use of quintozene has been stopped in most UNECE countries. Traces of pentachlorobenzene can also be found in several other fungicides, herbicides and pesticides. In conclusion, production and use of this substance in Europe and North America are negligible, but the situation in other parts of the world is less clear.
Releases to the environment	Several potential sources of releases to the environment of PeCB are identified. Total global emissions of this substance have been estimated in year 2007 in 85 tons/year (ICCA/WCC, 2007). It appears that at the global level, the most significant current source of PeCB releases proceed from incomplete combustion processes.
Status under international regulation	PeCB has been recently included in the POPs protocol of the LRTAP Convention. It is also regulated by the OSPAR Commission, and regional initiatives have been taken in North America and Europe

PFOS and PFOS-F	
Main characteristics	This group of substances is extremely persistent, since it has not showed degradation by hydrolysis, photolysis or biodegradation. The only know process that can degrade them is the incineration at high temperature. They are bioaccumulative, and their chemical properties show potential for long-range atmospheric transport. PFOS has been demonstrated as toxic to mammals in subchronic doses at low concentrations and toxic to aquatic organisms
Production and uses	3M, the biggest producer of PFOS ceased their manufacture in 2003, although there are some facilities in several parts of the World still producing them. They have been used in a wide variety of industrial processes across several sectors.
Releases to the environment	Manufacturing processes are considered to be the major source, but releases are likely to occur during their whole life cycle to atmosphere, soil and superficial and groundwater. Estimations on release ratio from use in products have been made.
Status under international regulation	PFOS have been recently included in the POPs protocol of the LRTAP Convention, with exemptions for several uses. It is also regulated by the OSPAR Commission. Regional initiatives have been taken in Europe and United States in order to restrict their use, and some countries have national regulations.

TetraBDE and pentaBDE (C-pentaBDE)	
Main characteristics	C-pentaBDE is reported to be persistent (from days to years), and with low degradation indexes. It has been detected in remote locations, indicating long range transport potential, and its chemical properties suggest bioaccumulation and biomagnification potential. Toxicity studies reveal neurodevelopmental impacts, neurotoxicity, reproductive damage and damages to the endocrine system.
Production and uses	Its estimated cumulative use since 1970 is 100,000 tonnes. It has been manufactured in several countries, but most of them phased out the production in the 1990s or the 2000s. It has been used in several sectors, mainly as fire retardant, being the most common in polyurethane foams for furniture and upholstery.
Releases to the environment	PentaBDE is released into the environment during several stages the life cycle of containing articles, from the manufacturing process of the actual chemical, in the manufacture of containing products, during their use and after they have been discarded as waste.
Status under international regulation	Tetra- and pentaBDE have been recently included in the POPs protocol of the LRTAP Convention with some exemptions. They are also regulated by the OSPAR Commission. It is in process of being included in the Rotterdam Convention, and regional initiatives have been taken in EU (where it is banned) and the Artic region's countries. National legislation has also been developed in some countries, being most of it towards establishing restrictions in production or imports of articles

Alternative chemicals

The best possible management strategy to minimize the risks of a hazardous substance is the substitution for less harmful alternative chemicals, but with similar effects in the required applications. However, in many cases there are other options involving earlier stages in the decision making process when tackling the problem of finding suitable alternatives such as changes to product design and materials, or finding other non-chemical alternatives.

A detailed description of the alternative substances and some processes available in the market for the chemicals tackled in this report is provided in section 5 of the main document. The following table displays a general overview on this issue.

Chemical	Availability of alternative
Alpha-hexachlorocyclohexane (α-HCH)	No alternatives. It's a by-product
Beta-hexachlorocyclohexane (β-HCH)	No alternatives. It's a by-product
Chlordecone	Yes
Hexabromobiphenyl (HBB)	Yes, for some uses
Hexabromodiphenyl ether and heptabromodiphenyl ether	Yes, for some uses
Lindane (γ-HCH)	Yes
Pentachlorobenzene (PeCB)	No. It's no longer used
Perfluorooctane sulfonic acid (PFOS) and its salts	Yes, for some uses
Perfluoroctane sulfonyl fluoride (PFOS-F)	Yes, for some uses
Tetrabromodiphenyl ether and pentabromodiphenyl ether	Yes, for some uses

Source: UNEP, 2009a.

Waste management

The new POPs listed to the annexes of the Stockholm Convention were used or have been in use for several years. Therefore, after the ban or severe restriction of these substances, an important issue to tackle is the management of the stockpiles in the warehouses of the production facilities, or the final disposal of those articles containing these substances that have been put in the market at the end of their lifespan.

According to the previsions of the Stockholm Convention, Parties shall manage stockpiles and wastes in a safe, efficient and environmentally sound manner, and take appropriate measures to ensure that POP wastes are handled, collected, transported, and stored in an environmentally sound manner.

Such strategies exist for all the new substances included in the Convention, and are described in section 6 of the main document.

The new POPs in the Mediterranean Region

Although there is more information for some substances than for others, a representative statement for the whole region could be that actual data on the new POPs regarding the countries party to the Mediterranean Action Plan is scarce and very scattered through several studies and reports.

Questionnaires were sent to several MAP contacts and experts on chemical management from each country, but only 11 of the 22 MAP parties have fulfilled and submitted the questionnaire, and none of the almost 60 international experts consulted by mail sent information.

From a general point of view, a difference in management strategies and progresses made can be established among the MAP developed countries, where more assets have been put into the fulfilling of the Stockholm Convention's requirements, and those considered as developing countries or countries with economies in transition. These countries face several problems in adapting their legal framework to comply with this sort of international agreements, or even to develop adequate monitoring programmes to be able to understand the real situation of use and management of the new chemicals regulated by the Convention.

The situation varies among countries and among substances, so it is difficult to summarize it here in a comprehensive manner. A **legal framework** exists in all EU countries, but regarding other MAP countries either regulations are inexistent, or the information is not complete. Substances that have been in the market for a long time, such as pentachlorobenzene or lindane, have already been banned for **production and use** in most of the countries, while for newer compounds the information is unclear in non-EU countries. Very little data is available regarding **stockpiles and contaminated sites**, although for those known cases, measures to manage the substances are reported to be under development. Finally, regarding the **viability of substitution**, for those cases where a certain initial investment is required, developing countries or countries with economies in transition may have difficulties, and might require some international financial support or technical assistance. In those countries, substitution might be hindered by the lack of a legal framework, political will or lack of technical knowledge or capacity. In some cases, the obstacle lays in earlier stages of the substitution process, since there is no knowledge of the usage of the new POPs in the country, and monitoring programmes to evaluate the existence of stockpiles have not been put in place. On the other side, for EU Members, substitution has mostly already taken place, or is under development.

A detailed profile for those 11 countries that submitted information is provided in section 8 of the main document.

Conclusions

In view of the information compiled through the bibliographic research and previous studies on POPs, and of the data gathered through the questionnaires sent by the relevant national authorities, the following conclusions are established for this diagnosis:

1. Actual data on the new POPs regarding the countries party to the Mediterranean Action Plan is scarce and very scattered through several studies and reports.
2. Regarding the **legal framework**, managing strategies and progresses made towards the elimination of the new POPs are different for MAP EU Member States countries and those not being members of the European Union.
3. EU Members have strategies and mechanisms already in place to manage all the new POPs, and have banned their use or have established a schedule for the phasing out.
4. As a general approach, the situation for non-EU MAP countries is less clear: some of them report to have EU legislation as a model to follow, but not all the new POPs are covered by national regulations.
5. MAP Parties considered as developing countries or countries with economies in transition face several problems in adapting their legal framework to comply with international agreements. Furthermore, most of them cannot even succeed in developing monitoring programmes to evaluate the actual situation of production, use, stockpiles, waste or contaminated sites, mainly due to the lack of financial or technical capacity.
6. With regard to the availability of **substitutes**, both alternative chemicals and alternative process are feasible at a global scale (except some specific uses of some substances). Thus, it can be assumed that the substitution at a regional level is possible, although it might face some barriers to overcome such as extra costs of the alternative substances or processes (in some cases) and technical suitability. Other impediments can arise from deeper and sometimes more difficult obstacles to subdue like inadequate or inexistent training and communication strategies that can lead to social impediments against the substitution process among the stakeholders involved.
7. **Waste management** is carried out in an environmentally sound manner when the appropriate legal framework exists. The information obtained does not allow to state clearly if wastes from the new POPs are properly managed in non-EU MAP countries. In the EU Member States, the national and regional authorities

exert a tight control over producers to ensure the ESM of wastes, so it can be assumed that most of them are managed according the legal principles.

8. Regarding the **stockpiles**, although some countries are in position to confirm their existence or absence, in many cases the information is not available due to the lack of monitoring programmes.
9. There are some historically identified cases of **contaminated sites** for some countries, but for the majority of them very little information is available. However, independent studies lead to believe that due to the past utilization of some of the new POPs (mostly in the case of pesticides), sites might arise in the future when proper evaluations are carried out.
10. The low success rate in the questionnaire's responses, despite the efforts made and the exhaustive follow up, can denote a lack of actual knowledge on new POPs in the region.

Proposals at regional level

EU Members should focus on the compliance of current EU legislation and the phasing out schedule of some of the new POPs. Some of the questionnaires reported not knowledge on several important aspects about some of the new POPs, such as the existence of a national regulation, stockpiles, contaminated sites or even ESM of wastes. With the listing of these substances to the Stockholm Convention, this lack of data in some areas should be solved establishing control mechanisms to retrieve up to date information that allows absolute knowledge of these substances at a national level. These countries should also be prepared to provide financial and technical support to those other countries with limited capabilities to develop the appropriate strategies towards the elimination of the new POPs without external assistance.

In non-EU Members, where the level of management strategies and knowledge on the situation is, in many cases, unclear, efforts should be put in early stages on the establishment of management strategies, such as the development of monitoring activities to achieve an understanding of the reality of these substances in the country, as a first step towards building a legal framework robust, nation-wide applicable and adapted to the countries' needs. Among this group of MAP parties, developing countries face bigger problems due to the lack of technical and financial capacity to confront such activities.

The MAP countries should start the process of updating their National Implementation Plans (NIP), since the revised NIPs shall be transmitted to the Conference of the Parties of the Stockholm Convention within two years of the entry into force of the amendments to the Convention, i.e. before 26 August 2012.

For those countries with little knowledge on the status of the new POPs in their territory, an initial assessment is required, for which they can request capacity building activities. The CP/RAC, as Regional Centre under the Stockholm Convention, can assist them in the implementation of the Convention.

Finally, it should not be overlooked the importance of promoting cooperative reinforcement activities among all the international agreements related to hazardous substances, like the Rotterdam and Basel Convention, the LRTAP Protocol, OSPAR Commission or SAICM, among others.

1. Introduction

The Regional Activity Centre for Cleaner Production (CP/RAC) is one of the six Regional Activity Centres (RAC) of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme. The mission of CP/RAC is to contribute to pollution prevention and sustainable and efficient management of services, products and resources based on the SPC integrated approach adopted by UNEP and the sound chemical management in the Mediterranean. In addition, the CP/RAC was endorsed in May 2009 as a Regional Centre under the Stockholm Convention on Persistent Organic Pollutants (POPs) for capacity building and transfer of technology in the Mediterranean Region.

The Conference of the Parties of the Stockholm Convention, at the fourth meeting of the Parties held from 4 to 8 May 2009 in Geneva, considered the recommendation of the POPs Review Committee and decided on listing nine new chemicals under Annex A, B or C.

One of the challenges of the CP/RAC is to promote among the Mediterranean Countries the incorporation of the new POPs in the local and regional legal measures and strategies, and in the National Implementation Plans of Stockholm Convention. In this framework, the CP/RAC has prepared this diagnosis of the new POPs in the Mediterranean Region as part as its work programme.

Furthermore, the 16th Meeting of the Contracting Parties of the Barcelona Convention, in its decision IG.19/10, urges the Contracting Parties to agree to start working with the support of MEDPOL and CP/RAC with a view to preparing Regional Plans/Programmes pursuant to Article 15 of the LBS Protocol, on the new POPs included in the Stockholm Convention. The present assessment will be considered as the basis for the development of the Regional Plan on the new POPs, to be submitted to the Conference of the Parties of the Barcelona Convention in its 17th Meeting.

2. Objectives and Scope

2.1 Objectives

The main objective of this study is to assess the current situation on the production, uses, consumption and waste management of the new chemicals listed in the annexes of the Stockholm Convention.

Furthermore, the report comprises an analysis of the existent alternatives in the market to those substances, and the degree of substitution achieved.

Finally, once the available information has been compiled and examined, it is provided a set of guidelines and proposals of actions for the Mediterranean countries to adjust to the new requisites of the Convention, and to adapt their National Implementation Plans.

2.2 Scope

The scope of this report covers the 21 countries of the Mediterranean Action Plan (MAP): Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia and Turkey.

The nine new chemicals listed to the annexes of the Convention, and thus, the ones on which this study focuses, are the following:

- Alfa hexachlorocyclohexane (α-HCH)
- Beta hexachlorocyclohexane (β-HCH)
- Chlordecone
- Hexabromobiphenyl (HBB)
- Tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE)
- Hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE)
- Lindane (γ-HCH)
- Pentachlorobenzene (PeCB)
- Perfluorooctane sulfonic acid (PFOS),its salts, and perfluoroctane sulfonyl fluoride (PFOS-F)

It should be noticed that tetra-BDE and penta-BDE are the main components of the commercial pentabromodiphenylether (c-pentaBDE), and hexaBDE and heptaBDE are the main components of the commercial octabromodiphenylether (c-octaBDE). Hence, these two products are indirectly included in the analysis.

3. International framework

This section is a summary of the main international agreements related to chemicals management affecting directly or indirectly the MAP countries.

3.1 The MAP, the Barcelona Convention and the MED POL

The **Mediterranean Action Plan (MAP)** is a regional cooperative effort to protect the marine and coastal environment of the Mediterranean, and to promote regional and national plans to achieve the region's sustainable development. It as adopted in 1975 by 16 countries and today involves 21 countries bordering the Mediterranean Sea, and the European Union.

In 1976, the initial 16 countries forming the MAP adopted The **Barcelona Convention** or the Convention for the Protection of the Mediterranean Sea Against Pollution, including seven protocols to address specific aspects of Mediterranean environmental conservation:

- Dumping Protocol (from ships and aircraft)
- Prevention and Emergency Protocol (pollution from ships and emergency situations)
- Land-based Sources and Activities Protocol (LBS Protocol)
- Specially Protected Areas and Biological Diversity Protocol
- Offshore Protocol (pollution from exploration and exploitation)
- Hazardous Wastes Protocol
- Protocol on Integrated Coastal Zone Management (ICZM)

The initial focus of the MAP was aimed at marine pollution, but over the years aimed to include other aspects related to the protection of the Mediterranean. In 1995, the Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II) was adopted by the Contracting Parties to replace the Mediterranean Action Plan of 1975.

At the same time, the Contracting Parties adopted an amended version of the Barcelona Convention of 1976, renamed **Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean**.

The **MED POL** is the marine pollution assessment and control component of the MAP, and is responsible for the follow up work related to the implementation of the LBS Protocol and the Dumping and Hazardous Wastes Protocols. The MED POL Programme promoted the adoption by the Contracting Parties to the Barcelona Convention of a Strategic Action Programme (SAP MED). This is an action-oriented initiative identifying priority target categories of polluting substances and activities to be eliminated or controlled by the Mediterranean countries before the year 2025 with a planned time table for the implementation of specific pollution reduction measures and interventions. The key activities addressed in the SAP MED are linked to the urban environment, and to industrial activities, targeting those responsible for the release of toxic, persistent and bioaccumulative substances into the marine environment, giving special attention to persistent organic pollutants (POPs).

3.2 The Stockholm Convention

The **Stockholm Convention**, under the United Nations Environment Program (UNEP), focuses on the reduction and elimination of the Persistent Organic Pollutants (POPs). These substances meet characteristics of persistence, lipid solubility, toxicity and volatility so that their geographical distribution and accumulation present environmental and human health risks. The Convention aims to protect citizens and the environment from the effects of POPs.

The Stockholm Convention was adopted in 2001 and entered into force in 2004. It is a legally binding international instrument that requires Parties to take measures to eliminate or reduce the release of POPs into the environment. Parties shall prohibit the production and use of chemicals included in Annex A of the Convention, restrict the production and use of those chemicals included in Annex B for the acceptable purposes or specific exemptions, and take measures to reduce unintended releases derived from anthropogenic sources of chemicals listed in Annex C. In addition, Parties shall develop appropriate strategies for identifying and managing in a safe, efficient and environmentally sound manner stockpiles and wastes containing chemicals listed in Annex A and Annex B. The 12 chemical initially listed in the Convention were:

- Annex A:

  Aldrin
  Chlordane
  Dieldrin
  Endrin
  Heptachlor
  Hexachlorobenzene (HCB)

Mirex
Toxaphene
Polychlorinated Biphenyls (PCB)

- Annex B:

  DDT (1, 1, 1-trichloro-2, 2-bis (4-chlorophenyl) ethane)

- Annex C:

  Polychlorinated dibenzo-p-dioxins (PCDD)
  Polychlorinated dibenzofurans (PCDF)
  Hexachlorobenzene (HCB)
  Polychlorinated biphenyls (PCB)

According to Article 7 of the Convention, countries that have ratified the Convention have two years from the date of entry into force to develop National Implementation Plans (NIPs) to enable them to fulfil the obligations of accession to the Convention, and submit it to the Secretariat.

The Convention also considers provisions aimed to include new chemicals with similar characteristics to POPs through the POPs Review Committee(POPRC), a subsidiary body to the Stockholm Convention established for reviewing chemicals proposed for listing in Annex A, B, and/or C. Any party may submit a proposal to the Secretariat for listing a new chemical in the Annexes of the Convention. This proposal is submitted to the POPRC, and if the relevant criteria are fulfilled, the Secretariat invites all Parties and observers to provide technical information, with which the POPRC develops a Risk Profile. If on behalf of that document the POPRC decides that the proposal shall proceed, the Secretariat invites all Parties and observers to provide technical comments and socio-economic information for the POPRC to develop a Risk Management Evaluation. After this process, the Conference of the Parties decides whether to list the chemical in the annexes and specifies its related control measures.

At its fourth meeting, held in Geneva in May 2009, the Conference of the Parties (COP) considered the recommendations of the POPRC and decided on listing nine new chemicals under Annexes A, B and C through decisions SC-4/10 to SC-4/18. These chemicals are shown in Table 1 below.

Table 1: The new POPs

Chemical	Listed in Annex	Acceptable purpose or specific exemption
Alpha-hexachlorocyclohexane (α-HCH)	A	None
Beta-hexachlorocyclohexane (β-HCH)	A	None
Chlordecone	A	None
Hexabromobiphenyl (HBB)	A	None
Hexabromodiphenyl ether (hexaBDE) and heptabromodiphenyl ether (heptaBDE)	A	Use of recycled articles containing this substance
Lindane (γ-HCH)	A	Pharmaceutical use
Pentachlorobenzene (PeCB)	A & C	None
Perfluorooctane sulfonic acid (PFOS) and its salts	B	Production for specific uses and uses for acceptable purposes
Perfluoroctane sulfonyl fluoride (PFOS-F)	B	Production for specific uses and uses for acceptable purposes
Tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE)	A	Use of recycled articles containing this substance

Source: UNEP, 2009a.

The POPRC decided to list tetraBDE and pentaBDE instead of their mixture known as commercial pentabromodiphenyl ether, since those two chemicals were also assessed and recommended for listing. The same situation occurred when assessing the proposal for listing of commercial octaBDE, where the POPRC decided on listing hexaBDE and heptaBDE instead the commercial mixture.

According to Article 22 paragraph 3(c) of the Stockholm Convention, the amendments of the annexes will enter into force one year after the communication by the Depositary of the adoption of the amendments, i.e. on 26 August 2010. They shall not enter into force for those Parties that have submitted a notification or those that have made a declaration, according with Article 22 paragraph 3(b) and Article 25 paragraph 4, respectively.

Parties should update their National Implementation Plan (NIP) after an amendment to the annexes of the Convention. The process to do so was accorded in Decision SC-2/7, in conformity with Article 7, and establishes that the revised NIPs should be transmitted to the Conference of the Parties within two years of the entry into force of the amendments to the Convention. According to this, Parties that have not submitted a notification or made a declaration should update their NIPs before 26 August 2012.

The following MAP countries have ratified the Stockholm Convention: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Lebanon, Libya, Monaco, Montenegro[2], Morocco, Slovenia, Spain, Syria, Tunisia and Turkey. Israel, Italy and Malta are signatories to the Convention but they have not yet ratified it.

3.3 Other International Conventions in Chemical Management

3.3.1 Rotterdam Convention

The objectives of the Convention are to promote shared responsibility and cooperative efforts among Parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm; and to contribute to the environmentally sound use of those hazardous chemicals, by facilitating information exchange about their characteristics, by providing for a national decision-making process on their import and export and by disseminating these decisions to Parties.

The Rotterdam Convention was adopted on 10 September 1998 by a Conference of Plenipotentiaries in Rotterdam, and entered into force on February 24, 2004. The Convention creates legally binding obligations for the implementation of the Prior Informed Consent (PIC) procedure.

The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties and which have been

[2] Montenegro adopted its Declaration of Independence on 3 June 2006, and “decided to succeed to the treaties to which the State Union of Serbia and Montenegro was a party or signatory”

notified by Parties for inclusion in the PIC procedure. This procedure is a mechanism to officially receive and disseminate the decisions of the importing Parties as to whether they wish to receive future shipments of chemicals listed in Annex III of the Convention and to ensure compliance with these decisions by exporting Parties.

There are 39 chemicals listed in Annex III of the Convention and subject to the PIC procedure, including 24 pesticides, 4 severely hazardous pesticide formulations and 11 industrial chemicals. Many more chemicals are expected to be added in the future. The Conference of the Parties decides on the inclusion of new chemicals.

The following MAP countries are Party to the Rotterdam Convention: Bosnia-Herzegovina, Croatia, Cyprus, France, Greece, Israel, Italy, Lebanon, Libya, Slovenia, Spain, Syria, Tunisia and Turkey.

3.3.2 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal aims to protect human health and the environment against the adverse effects of the generation, management, transboundary movement and disposal of hazardous and other wastes. The Basel Convention was adopted in 1989 and entered into force on May 5, 1992.

The Basel Convention regulates the transboundary movements of hazardous and other waste by applying the "Prior Informed Consent" (shipments without consent are illegal). Shipments to and from non-Parties are illegal unless there is a special agreement. Each Party is required to introduce appropriate national or domestic legislation to prevent and punish illegal traffic in hazardous and other wastes. Illegal traffic is criminal. Furthermore, the Convention obliges its Parties to ensure that hazardous and other wastes are managed and disposed of in an environmentally sound manner (ESM). To this end, Parties are expected to minimize the quantities that are moved across borders, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source. Strong controls have to be applied from the moment of generation of a hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. In this regard, the Parties to the Convention must report annually information and data about the implementation of the Convention through their respective focal points.

All the MAP countries comprised in this study are signatories to the Basel Convention.

3.3.3 Strategic Approach to International Chemicals Management (SAICM)

The Strategic Approach to International Chemicals Management (SAICM) was adopted by the International Conference on Chemicals Management (ICCM) on 6 February 2006 in Dubai (United Arab Emirates); SAICM is a policy framework to foster the sound management of chemicals.

SAICM was developed by a multi-stakeholder and multi-sectorial preparatory Committee and supports the achievement of the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that, by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health.

SAICM consists of three basic texts:

- The **Dubai Declaration** expresses the commitment of ministers, heads of delegation and representatives of civil society and the private sector to the SAICM.
- The **Global Strategic Policy** sets out the scope of SAICM, the needs to be addressed and the objectives for risk reduction, knowledge and information, governance, capacity building and technical cooperation and illegal international traffic.
- The **Global Action Plan** proposes work areas and activities for implementing the Strategic Approach grouped under five main themes: Risk reduction, Knowledge and information, Governance, Capacity-building and technical cooperation, and Illegal international traffic.

In the ICCM II, held in Geneva in May 2009, four emerging policy issues were identified for further work: Lead in paint, chemicals in products, hazardous substances within the life cycle of electrical and electronic products, and nanotechnologies and manufactured nanomaterials.

3.3.4 Convention on Long-range Transboundary Air Pollution

The Geneva Convention on Long Range Transboundary Air Pollution (LRTAP) was the main outcome of the High-level Meeting within the Framework of the Economic Commission for Europe held in 1978, and signed by 34 Governments and the European Community. The Convention aims that Parties endeavour to a limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution. Parties develop policies and strategies to combat the discharge of air pollutants through exchanges of information, consultation, research and monitoring.

The Convention, now including 51 Parties, entered into force in 1983, and has been extended by eight specific protocols. One of these protocols is the Protocol on Persistent Organic Pollutants, adopted by the Executive Body in 1998 in Aarhus (Denmark). It focuses on a list of 16 substances comprising eleven pesticides, two industrial chemicals and three by-products or contaminants. Its ultimate objective is to eliminate any discharges, emissions and losses of POPs. The Protocol bans the production and use of some products outright, being among them two of the new chemicals listed to the annexes of the Stockholm Convention: **chlordecone and hexabromobiphenyl** while others are scheduled for elimination at a later stage. In addition, the Protocol severely restricts the use of **hexachlorocyclohexane** (including **lindane**), among others. It also obliges Parties to reduce their emissions of certain substances, includes provisions for dealing with the wastes of products that will be banned, and sets specific limit values for the incineration of municipal, hazardous and medical waste.

The Protocol has been signed and ratified by the following MAP countries: Croatia, Cyprus, France, Greece (signed in 1998, not yet ratified), Italy, Malta, Slovenia, Spain and Turkey, so it’s previously mentioned provisions shall apply in these countries.

3.3.5 OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic

Since 1972 the OSPAR Convention has worked to identify threats to the marine environment and has organised, across its maritime area, programmes and measures to ensure effective national action to combat them. In doing so it has pioneered ways of ensuring monitoring and assessment of the quality status of the seas by setting internationally agreed goals and by checking that the participating Governments are delivering what is needed.

This convention was actually originated from the merging of the 1972 Oslo Convention against dumping later broadened to cover land-based sources and the offshore industry by the Paris Convention (1974). These two conventions were unified, up-dated and extended by the OSPAR Convention in 1992.

Within this framework, the OSPAR Commission meets normally once a year to discuss North-sea protection issues. This Commission is the forum through which the Contracting Parties cooperate, and is supported by six main committees tackling different aspects: environmental Assessment and Monitoring (ASMO), biodiversity

(BDC), eutrophication (EUC), hazardous substances (HSC), offshore industry (OIC) and radioactive substances (RSC).

Work to implement the OSPAR Convention and its strategies is taken forward through the adoption of decisions, which are legally binding on the Contracting Parties, recommendations and other agreements which set out actions to be taken by the Contracting Parties.

3.4 Synergies among Conventions and Strategies

Some of the Conventions and international strategies above described have similarities in terms of their scope and objectives. This is particularly evident for the case of Rotterdam, Basel and Stockholm Conventions. For this reason they have adopted decisions to establish an ad hoc joint working group (AWJWG) to prepare joint recommendations for greater cooperation and coordination between the three Conventions. This working group has already produced a series of recommendations aimed at enhancing cooperation and coordination in the common areas of the three conventions, including:

1. Protection of human health and the environment from the harmful impacts or adverse effects of hazardous chemicals and wastes;
2. Prevention of accidents and emergency response in case of accidents;
3. Combating illegal traffic and trade in hazardous chemicals and wastes;
4. Information generation and access;
5. Technology transfer and transfer of know-how;
6. Preparation of national positions for meetings of the Conferences of the Parties and other bodies of the Basel, Rotterdam and Stockholm Conventions;
7. Development cooperation;

In the so-called Synergies Decisions (IX/10, RC-4/11 and SC-4/34 of the Conferences of the Parties to Basel, Rotterdam and Stockholm Convention, respectively), the conferences of the Parties to the three conventions agreed, among other things, to convene simultaneous extraordinary meetings of the three conferences, at which the Parties would discuss matters relating to cooperation and coordination among the conventions. The first of these meetings was held in Bali, Indonesia, in February 2010, where delegates adopted an omnibus synergies decision on joint services, joint activities, and synchronization of the budget cycles, joint audits, joint managerial functions, and review arrangements (ISSD, 2009). The main outcome of this meeting was de Nusa Dua Declaration with sections related to climate change, sustainable development, international environmental governance, green economy, and biodiversity and ecosystems.

4. Available information and previous studies on the new POPs

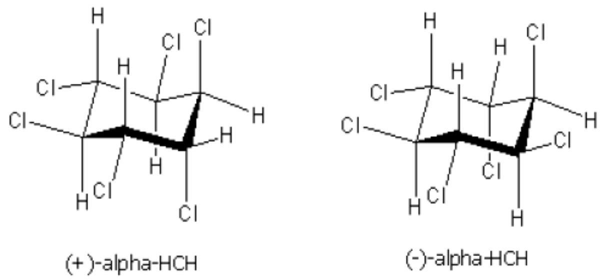
Most of the information on the new POPs listed in the annexes of the Stockholm Convention has been gathered through toxicological reviews carried out by the environmental agencies of several countries, such as the US EPA, the Danish EPA, the World Health Organization, etc. The most comprehensive and updated compilations, in terms of information provided are the Risk Profiles and the Risk Management Evaluations developed by the POPs Review Committee in the process of amendment of the Convention's annexes. This section is a compilation of the information gathered by previous studies.

4.1 Alpha- and Beta-hexachlorocyclohexane

4.1.1 Chemical and toxicological properties

The main characteristics of alpha- and beta-HCH are described in Table 2:

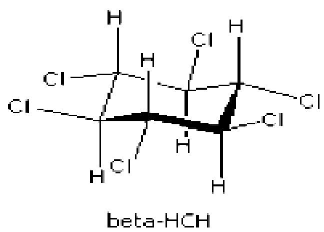
Table 2: Chemical identity and physico-chemical properties of α-HCH.

Characteristic	α-HCH
Structure	
IUPAC name	(1a,2a,3b,4a,5b,6b)-Hexachlorocyclohexane
Synonyms	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	319-84-6

Characteristic	α-HCH
Registered trade mark(s)	No data
Chemical formula	$C_6H_6Cl_6$
Molecular weight	290.83
Colour	Brownish to white
Physical state	Crystalline solid, monclilnic prisms
Melting point	150-160 ºC
Boiling point	288 ºC at 760 mmHg
Density (g/cm^3)	1.87 at 20 ºC
Water solubility	0.33 mol*m^{-3} at 25 ºC
Partition coefficient (Log K_{ow})	3.8
Vapour pressure	4.5x10-5 mmHg at 25 ºC

Source: ATSDR, 2005; UNEP, 2007a

Table 3: Chemical identity and physico-chemical properties of β-HCH.

Characteristic	β-HCH
Structure	
IUPAC name	(1-alpha, 2-beta, 3-alpha, 4-beta, 5-alpha, 6-beta)-Hexachlorocyclohexane

Characteristic	β-HCH
Synonyms	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	319-85-7
Registered trade mark(s)	No data
Chemical formula	$C_6H_6Cl_6$
Molecular weight	290.83
Colour	No data
Physical state	Crystalline solid
Melting point	314-315 ºC
Boiling point	60 ºC at 0.5 mmHg
Density (g/cm^3)	1.89 at 19 ºC
Water solubility	1.44 mol*m^{-3} at 25 ºC
Partition coefficient (Log K_{ow})	3.78
Vapour pressure	3.6x10^{-7} mmHg at 20 ºC

Source: ATSDR, 2005; UNEP, 2007a

According to these physico-chemical properties, both compounds accumulate in the poles through the so-called process “cold condensation” after long range transportations from sources. Hydrolysis contributes to the removal of alpha-HCH in aqueous solution under alkaline pH, but it is not so important under environmental conditions, and beta-HCH is biodegradable by various microbial strains under favourable conditions at a very slow decrease rate in the environment. Thus, both substances can be considered to be persistent in the environment. Monitoring activities in several locations showed higher concentrations of these compounds in upper trophic levels, indicating their bioaccumulation properties. Studies have been developed in laboratory animals, concluding to have neurological, hepatological, reproductive, immunosuppressive and carcinogenic effects. (UNEP, 2007a, UNEP, 2007b)

4.1.2 Production and uses

Alpha-HCH and beta-HCH are not intentionally produced for commercial uses, and they do not occur as a natural substance. They are a by-product from the manufacturing of technical HCH through the photochlorination of benzene, which yields an isometric mixture of alpha-, beta-, gamma-, delta- and epsilon-HCH, in the following proportions (World Bank, 2010; ATSDR, 2005):

- α-HCH: 55-80%
- β-HCH: 5-14%
- γ-HCH: 8-15%
- δ-HCH: 6-10%
- ε-HCH: 1-5%

Technical HCH is used as organochlorine insecticide or chemical intermediate to manufacture gamma-HCH (Lindane). Currently, there is no production of technical HCH, although manufacture of Lindane might still occur which could lead to the existence of stocks of α-HCH and β-HCH as wastes, since the production of one ton lindane generates up to eight tons alpha- and beta-HCH (UNEP, 2008a)

Regarding the usage of these substances, it is estimated that approximately 400,000 tons of technical HCH were used in Europe alone between 1970 and 1996 (Breivik et al., 1999 in UNEP, 2007a). Li et al. (1999) (in UNEP, 2007a) estimates that around ten million tones of technical HCH were released into the environment between 1948 and 1997. There are several countries that led the consumption of this substance worldwide in the past, being China the first one, consuming almost half of the total global quantity, and 9 other countries consuming the other half, in order of decreasing usage: Former Soviet Union, India, **France**, **Egypt**, Japan, United States, East Germany, **Spain** and Mexico (Li and Macdonald, 2005 in UNEP 2007a). However, most countries have been banning the utilization of technical HCH since de 1970s, being India the last one in joining the trend in 1990. For this reason, the usage of this substance steadily declined and now is virtually no longer used in the World since 2000 (Li and Macdonald, 2005 in UNEP, 2008a). However, there are studies that indicate that limited use of stockpiles for public health purposes and/or illegal use still occur (Zhulidov et al., 2000; Bakore et al., 2004; Qian et al., 2006, in UNEP 2007a).

4.1.3 Releases to the environment

There are several ways of alpha- and beta-HCH for entering the environment. Releases into the atmosphere from technical-HCH manufacturing facilities have historically been the main pathway. Both substances have the same global emission patters, but differ in scale, accordingly to the different proportions in which these by-products appear in technical HCH and lindane production. Based on data on technical HCH an estimated quantity of 4.3 million tones of alpha-HCH and 230,000 tones of beta-HCH have been emitted into the atmosphere. Emissions of these substances started to increase after the 1940s, with a peak in the early 1970s. Then, the figures started to drop because of the prohibition on the use in North America, Europe and Japan. However, but reached another peak in 1980s, due to the expanding usage in China. After the 1980s, figures dropped due to the further restrictions (UNEP, 2007a).

Releases of alpha- and beta-HCH into the environment are also possible from hazardous waste sites (USEPA, 2006), stockpiles of lindane and residues of lindane production from former production sites (IHPA, 2006; Concha-Grana et al., in UNEP 2007a).

4.1.4 International framework and regulations

Alpha and beta-HCH are regulated through two international agreements, in addition to the Stockholm Convention.

The Aarhus Protocol on Persistent Organic Pollutants from the LRTAP Convention restricts the use of technical HCH (formed by α-HCH and β-HCH, among others isomers, as already mentioned) to an intermediate in chemical manufacturing, since they are listed in Annex II of the aforementioned Protocol.

Likewise, the Rotterdam Convention lists mixed isomers of HCH in its Annex III, meaning that those compounds are subject to the PIC procedure explained in section 3.3.1.

Regional measures have been taken by countries such as Canada, Mexico and the United States through the North American Action Plan on Lindane and other HCH isomers, focusing on the risk to humans for exposure to these substances.

Furthermore, HCH isomers are also included on the List of Chemicals for Priority Action under the OSPAR Commission

The European Union restricted to Member States the production and use of technical HCH in 2007 as latest through Regulation (EC) 850/2004, on persistent organic pollutants. Regulations (EC) 1196/2006 and 172/2007 deal among others with concentration limits for HCH (including alpha-, beta- and gamma-HCH) in waste. Finally, the adopted EU Water Framework Directive 2000/60/EC includes HCH among the priority substances (Decision 2455/2001/EC).

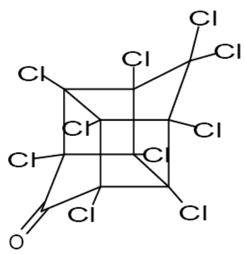
Measures at a national level towards these compounds have been identified in countries like Armenia, Republic of Moldova and Republic of Korea. Further information specifically related to the Mediterranean countries, if available, will be provided in section 7.

4.2 Chlordecone

4.2.1 Chemical and toxicological properties

The main characteristics of chlordecone are described in Table 4.

Table 4: Chemical identity and physico-chemical properties of chlordecone.

Characteristic	Chlordecone
Structure	
IUPAC name	1,1a,3,3a,4,5,5,5a,5b,6Decachlorooctahydro- 1,3,4metheno- 2H-cyclobutapentalen-2-one
Synonyms	Decachloroketone; decachlorooctahydro-1,3,4-metheno- 2H-cyclobutajpentalen-2-one
CAS	143-50-0
Registered trade mark(s)	GC 1189; ENT16391; Kepone; Merex
Chemical formula	$C_{10}Cl_{10}O$
Molecular weight	490.64
Colour	Tan-white
Physical state	Crystalline solid
Melting point	Decomposes at 350°C
Boiling point	No data
Density	1.61 g/mL at 25°C

Characteristic	Chlordecone
Water solubility	2.70 mg/L at 25°C
Partition coefficient (Log K_{ow})	5.41
Vapour pressure	2.25 $\times 10^{-7}$ mm Hg at 25 °C

Source: USEPA, 2009; US ATSDR, 1999

According to the available data and the physico-chemical properties shown above, chlordecone can be considered as highly persistent in the environment. It is not expected to hydrolyse or biodegrade in aquatic environments or in soil. Photodegradation is not significant and it does not show signs of volatilisation. Several studies show high bioaccumulation and biomagnification potential.

Regarding its toxicity, it has been proved to be both acutely and chronically toxic, producing neurotoxicity, immunotoxicity, reproductive, musculoskeletal and liver toxicity at doses between 1-10 mg/Kg bw/day. It is considered as possible human carcinogen by the International Agency for Research on Cancer. Moreover, this substance has been proved to be very toxic to aquatic organisms, especially to invertebrates.

When it comes to long-range atmospheric transport the available information is not conclusive due to the lack of monitoring activities. However, according to its physico-chemical properties and modelling simulations clearly indicate high long-range environmental transport potential (UNEP, 2007g).

4.2.2 Production and uses

Chlordecone production process begins with the condensation of hexachlorocyclopentadiene with sulphur trioxide under heat and pressure with antimony pentachloride as a catalyst. The product of this reaction is hydrolyzed and then neutralized. Chlordecone is obtained by centrifugation or filtration and hot air drying (USEPA, 2009).

The production of chlordecone started in the United States in the early 1950s by Allied Chemicals and it was introduced commercially in 1958 under the trade name Kepone and GC-1189 (UNEP, 2007g).

Approximately 3.6 million pounds of chlordecone were produced in the United States between 1951 and 1975 (ATSDR, 1995). Chlordecone production in the United States ended in 1975 after intoxication from severe industrial exposure was observed in employees who worked at the only chlordecone manufacturing plant in the country. Approximately 90-99% of the total volume of Chlordecone produced during this time was exported to Europe, Asia, Latin America, and Africa (UNEP, 2007g).

Chlordecone is also a contaminant in mirex formulations up to 2.58 mg/kg (technical mirex) or 0.25 mg/kg (mirex bait formulations). Thus, it is expected to occur in the degradation processes of mirex stockpiles (USEPA, 2009).

Chlordecone was primarily used as an insecticide for the control of the banana root borer in the tropics, application on non-fruit-bearing citrus trees to control rust mites, control of wireworms in tobacco fields, control of apple scab and powdery mildew, control of the grass mole cricket, and control of slugs, snails, and fire ants. It is regarded as an effective insecticide against leaf-cutting insects, but not so much against sucking insects. It has also been used in household products such as ant and roach traps ant low concentrations. Other identified uses are as fly larvicide and fungicide. (ATSDR, 1995; USEPA, 2009; UNEP, 2007g)

Production and use of chlordecone has been reported to have ceased over the last decades in developed countries, but it can still be produced or used as an agricultural pesticide in some developing countries. If it is still used as pesticide, it will be directly released to the environment. Moreover, the high persistency of the substance has caused high contamination of soil and waters in the areas where it has been used and these contaminated sites can serve as a source of pollution for long times (UNEP, 2007g).

4.2.3 Releases to the environment

Since chlordecone is used as a pesticide, it is assumed that all produced amounts have been finally released to the environment through direct applications to crops. Severe contamination of soil and surface water has been reported in Martinique and Guadeloupe until 1993, and are currently being monitored.

In the pesticide application, major releases of chlordecone occurred to the air, surface waters due to particles runoff with rains, and groundwater contamination through percolation. In the surroundings of the manufacturing facilities in USA have been monitored high concentrations of this substance.

4.2.4 International framework and regulations

Chlordecone is listed in Annex I of the Protocol on POPs to the Convention on LRTAP, which obliges parties to phase out all production and uses of this substance without any exemption. It is also listed in the OSPAR Convention as a substance of possible concern, and as substance for priority action under the Convention on the Protection of the Marine environment of the Baltic Sea Area (HELCOM Convention), thus is scheduled for elimination

The Basel Convention makes no specific reference to chlordecone, but it includes Mirex, a very similar compound, already listed in the Stockholm Convention. However, Annex VIII of the Basel Convention classifies as hazardous off-specification or out-dates pesticides, so chlordecone could be covered under this precept.

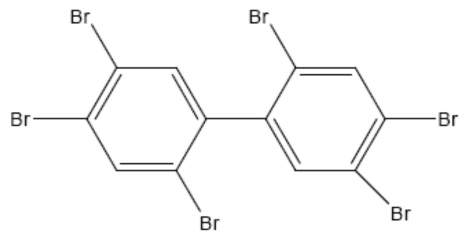
Chlordecone is currently not listed in the Rotterdam Convention, although it might be included in the near future, since documentation sent by Thailand has been verified to meet the requirements of Annex I of the Convention.

At a national level, actions have been taken by Germany, Canada, USA, Switzerland, Thailand, Japan and Mauritius, being prohibited the importation, manufacture, use or possession of chlordecone, depending on the actual regulation (UNEP, 2007g; UNEP, 2007h).

4.3 Hexabromobiphenyl

4.3.1 Chemical and toxicological properties

The main characteristics of hexabromobiphenyl are described in Table 5.

Characteristic	HBB
Structure	
IUPAC name	Hexabromo -1,1'-biphenyl
Synonyms	Hexabromobiphenyl; Biphenyl, hexabromo; 1,1'- biphenyl, hexabromo; HBB
CAS	36355-01-8 (hexabromo mixture) 59536-65-1 (BP-6) 67774-32-7 (FF-1)
Registered trade mark(s)	FireMaster(R) BP-6; FireMaster(R) FF-1
Chemical formula	$C_{12}H_4Br_6$
Molecular weight	627.58
Colour	White
Physical state	Solid
Melting point	72 °C
Boiling point	No data
Density (g/cm^3)	No data
Water solubility	3-11 µg/L (depending on sources)
Partition coefficient (Log K_{ow})	6.39
Vapour pressure	$6.9x10^{-6}$ Pa at 25 °C

Source: US ATSDR, 2004; UNEP, 2006d

Hexabromobiphenil belongs to a wider group of polybrominated biphenyls (PBBs) which have been proved to be persistent under field conditions, since years after an accidental release in a manufacturing site, the substance was found in monitoring activities. However, the congener composition was different than in the actual spill, indicating partial degradation in soil (World Bank, 2010).

The physico-chemical characteristics of HBB and test studies proved its high bioaccumulation capacity and bioconcentration along the food chain.

Arctic monitoring studies in wildlife found measurable concentrations of HBB, proving its long-range environmental transport potential.

This substance is considered by the International Agency for Research on Cancer as possible human carcinogen, and it has conclude endocrine disruption effects in rats mink and monkeys studies. Data in human show evidence of hypothyroidism in workers exposed to PBBs and increased incidence of breast cancer in exposed women.

4.3.2 Production and uses

The production of all polybrominated biphenyls involves the bromination of biphenyl through a Friedel-Crafts type reaction in which biphenyl is reacted with bromine in the presence of chloride in an organic solving, using aluminium chloride, aluminium bromide or iron as catalyst (UNEP, 2006d)

The commercial production of PBBs began in 1970, and about 5.4 million kg of HBB were produced from 1970 to 1976. Over 98% of the HBB was produced as FireMaster BP-6 and the residuals as FireMaster FF-1. The sole production of this substance in the United States, Michigan Chemical Corporation, stopped the production of HBB in 1975 after an agriculture contamination episode (US ATSDR, 2004; UNEP, 2007i).

According to the information available, production of HBB has ceased in most countries, but it is possible that it is still produced in some developing countries but in countries with economies in transition (UNEP, 2007i). However, no actual data has been found in the bibliographic research.

HBB was used primarily as flame retardant in three main commercial products: acrylonitrile-butadiene-styrene (ABS) thermoplastics for constructing 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 (UNEP, 2007i). The bigger amounts were used in ABS plastic and in cable coatings.

4.3.3 Releases to the environment

Data available on releases to the environment refers only to the United States, with reported losses of PBBs (no data on HBB) of up to 51 kg/1000kg. The most common pathways were, in order of importance, to air during production, solid losses to landfill from drying, handling, shipping and transportation, to soil in bagging and loading areas, and to waste water from the quenching and washing of the PBBs as they were recovered from the reaction mass (UNEP, 2006d).

HBB releases to the environment can arise from the widespread used as flame retardant, and it is expected that these releases carry on for long periods, due to the high stability of this substance.

Most of the electronic and plastic equipment in the US containing HBB is expected to have been disposed of by landfilling or incineration, since the life span of these products manufactured in the 1970s-80s was estimated in 5 to 10 years.

4.3.4 International framework and regulations

Hexabromobiphenyl is listed in Annex I of the LRTAP Convention's Protocol on POPs with no exemptions for production or use. Consequently, all parties shall phase out all productions and uses of this substance.

The UNEP/FAO Rotterdam Convention includes HBB among other PBBs, so the Prior Informed Consent (PIC) procedure must be followed in case of international trade of this chemical.

PBBs, including HBB, are listed in Annex VIII of the Basel Convention as hazardous substances, so all the provisions of the Convention apply for Parties carrying out transboundary movements of wastes containing HBB.

Under the OSPAR Convention, brominated flame retardants, including HBB, are part of the List of Chemicals for Priority Action. In its latest document, recommends supporting several measures taken by the European Community on PBBs, and to develop an OSPAR monitoring strategy for several PBBs.

The Helsinki Convention on the Protection of the Marine Environment of the Baltic Sea Area (HELCOM) HBB is scheduled for elimination, since is listed as substance for immediate priority action.

The Strategic Approach to International Chemicals Management (SAICM) does not specifically address HBB, but includes the persistent organic pollutants as a group of chemicals that shall be prioritized for assessment.

Regional actions have been tackled in the European Union. HBB is listed in Annex I to Regulation (EC) 850/2004 on persistent organic pollutants, which implies total ban of production and use in all the 27 Member States. The Directive 2002/96/EC on Waste from Electric and Electronic Equipment (WEEE) requires the separation of brominated flame retardants from waste prior to further treatment. Accordingly, RoHS Directive on Restrictions on Certain Hazardous Substances in Electric and Electronic Equipment (Directive 2002/95/EC) states in article 4 that from July 2006 electronic articles shall not contain PBBs. Specifically HBB is addressed in Regulation 850/2004/EC amended by Regulation 1195/2006/EC stipulating that wastes containing concentrations of HBB over 50/mg/kg have to be destroyed. Regarding the use of these substances in textiles, the prohibition was stabilised years ago by means of Directive 1976/769/EEC.

National strategies have been identified through reportings to the Secretariat of the Stockholm Convention by Canada, USA and Australia (UNEP, 2007i).

4.4 Hexabromodiphenyl ether and heptabromodiphenyl ether

As it has already be said above, the Convention decided on listing hexaBDE and heptaBDE instead the commercial octaBDE that was being assessed, since those two chemicals are main components of the commercial mixture. Therefore, this section will assess the characteristics of the commercial octaBDE, although similar properties apply to the separate substances.

4.4.1 Chemical and toxicological properties

The main characteristics of commercial octaBDE are described in Table 6.

Table 6: Chemical identity and physico-chemical properties of commercial octa-bromodiphenyl ether (c-octaBDE).

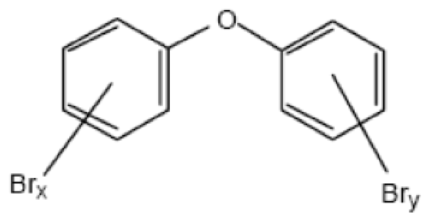
Characteristic	octaBDE
Structure	 x+y=8

Table 5: Chemical identity and physico-chemical properties of hexabromobiphenyl (HBB).

Characteristic	octaBDE
IUPAC name	Diphenyl ether, octabromo derivative (octabromodiphenyl ether, OctaBDE)
Synonyms	octabromobiphenyl oxide; octabromodiphenyl oxide; octabromo phenoxybenzene and benzene; 1,1' oxybis-, octabromo derivative
CAS	32536-52-0
Registered trade mark(s)	Not available
Chemical formula	$C_{12}H2Br_8O$
Molecular weight	801.38
Colour	Off-white
Physical state	Powder or flaked material.
Melting point	167-257oC, 130-155oC, 70-150oC (the commercial product has a melting range depending on the composition)
Boiling point	Decomposes at elevated temperature
Density (g/cm^3)	2.9
Water solubility	0.5 µg/l (commercial product)
Partition coefficient (Log K_{ow})	6.29 at 25 ºC
Vapour pressure	$6.59.10^{-6}$ Pa at 21 ºC (commercial product)

Source: UNEP, 2007j; European Commission, 2003.

Information on c-octaBDE alone is limited, since most studies focus on the whole family of congeners known as poly-bromodiphenyl ethers (PBDE). These substances have been shown to be very persistent in the environment, being the only identified degradation pathway until now photolysis, anaerobic degradation and metabolism in biota through debromination producing lower bromine congeners which might have higher toxicity and bioaccumulation potential.

This bioaccumulation potential has a direct relationship with the level of bromination, being lower brominated congeners more prone to bioaccumulate than those with higher bromine content.

Monitoring activities in remote areas have found c-octaBDE, proving its potential for long range environmental transport.

Regarding toxicity and ecotoxicity, the available information of the congeners hexa- to nonaBDE is very limited, and there are few studies showing no effects and unrealistic concentrations. However the design, exposure conditions and measured endpoints are not appropriate for a sound assessment of these types of chemicals, so this lack of effects should be considered with precaution (UNEP, 2007j).

4.4.2 Production and uses

According to the Environmental Health Criteria of the World Health Organisation on brominated diphenyl ethers, in the early 1990s there were eight producers of polybrominated diphenyl ethers (penta-, octa- or deca-) in the world (although industry indicated that there were nine producers world-wide), with one in the Netherlands, one in France, two in the United States, three in Japan and one in the United Kingdom. The same total number of manufacturers was reported by the risk assessment carried out by the Swedish National Chemicals Inspectorate in 1999, but production was also reported to occur in Israel as well. According to the latest information, none of the EU sites currently manufactures octaBDE (European Commission, 2003).

The available data on world-wide production in 1994 was estimated in 6,000 tones/year of octaBDE, being the demand in 1999 roughly below 4000 tones/year. For the same year, the marked demand in Europe as calculated in 450 tones/year, when an older study from 1994 estimated a European demand of 2,500 tones/year (UNEP, 2007j).

Like other PBDEs, c-octaBDE is mainly used as additive fire retardant in plastic and textile industries. Further information provided by industry indicates that octaBDE is always used in conjunction with antimony trioxide as catalyser. In Europe, it is primarily used in acrylonitrile-butadiene-styrene (ABS) polymers at 12-18% weight loadings in the final product. 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. These are then used in the polymer processing step to produce products with similar loadings as given above. The flame retarded polymer products are typically used for the housings of office equipment and business machines (UNEP, 2007j). Other uses that have been reported for octabromodiphenyl ether include nylon and low density polyethylene (WHO, 1994), polycarbonate, phenol-formaldehyde resins and unsaturated polyesters and in adhesives and coatings (WHO, 1994).

4.4.3 Releases to the environment

Releases to the environment have been reported to occur during the whole life cycle of the product, from manufacture to containing-article utilization.

During the production process, the most likely way in which octabromodiphenyl ether may reach water from its production is due to washing out of equipment. It is not clear how often this process is generally carried out or if it is carried out at all, and it would have to include possible releases to wastewater from washing down floors etc. of bagging areas and other areas where octabromodiphenyl ether dust can be generated. In the worse case scenario, the predicted loss from a 1,000 tonnes/year production site would be 3 tonnes/year to wastewater. If the lower emission factor of 0.5 kg/tonne is used, the release to wastewater would be around 0.5 tonnes/year.

Polymer application or processing includes various stages such as compounding (blending of the polymers with various additives) and conversion (production of the finished articles). Much of the loss from polymer applications is likely to be in the form of dust. Thus much of this will be collected for re-use or disposed of to landfill/incineration. However, some of this may end up in wastewater as a result of cleaning floors and equipment etc.

Losses of powders during the handling of raw materials for Europe have been estimated as 0.54 to 0.945 tonnes/year depending the consumption data used for the calculation. These losses will initially be to the atmosphere, but it is expected that the dust will rapidly settle and so losses will be mainly to solid waste, which may be recycled or disposed of, or washed to wastewater.

Releases from the compounding and conversion stages, or in the polymer procession site may also occur, but to a lesser extent.

Finally, losses may occur during the service life of the product containing c-octaBDE through volatilisation. Calculations based on its vapour pressure estimate releases of 0.54% of the initial quantity over ten years of product usage. This volatilization could also occur in case of landfilling as disposal option, and in that case, emissions to groundwater could appear by leaching. In case of incineration as means of final disposal, emissions are expected to be near zero (European Commission, 2003).

Complete information on expected environmental releases can be consulted in UNEP, 2007j.

4.4.4 International framework and regulations

In December 2009, on the 27th session of the Executive Body of the Convention on Long-range Transboundary Air Pollution adopted decisions to amend the annexes of its Persistent Organic Pollutants Protocol, listing hexabromodiphenyl ether and heptabromodiphenyl ether to Annex I of the Protocol, as substance scheduled for elimination without any exemptions for production and with the only exemption for use for recycling of articles that contain or may contain any of these substances, and the use and final disposal of articles manufactured from recycled materials that contain or may contain any of these substances, provided that the recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of any of these substances for the purpose of their reuse. Starting in 2013 and every four years the Executive Body shall evaluate the progress made towards the elimination, being 2030 the latest deadline (ECE, 2010). This inclusion implies, *de facto* the inclusion of c-octaBDE since those two congeners are their main components.

Brominated flame retardants are included in the OSPAR’s Commission List of Chemicals for Priority Action. C-OctaBDE is part of the List of Substances of Possible Concern, and although there are no specific measures targeting releases of brominated flame retardants, OSPAR has promoted activities related to them in the European Community, such as risk-reduction strategies and waste legislation for octaBDE, among others (UNEP, 2008e).

The Baltic Marine Environment Protection Commission (HELCOM) has included OctaBDE on its list of substances and substance-groups suspected to be highly relevant to the Baltic Sea and subjected to data and information collection from Contracting Parties (UNEP, 2008e).

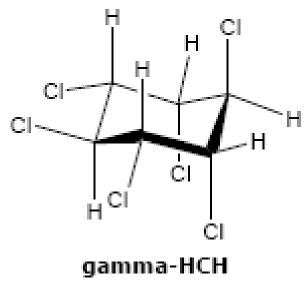
In 1995, OECD Member countries agreed to oversee a voluntary industry commitment (VIC) by the global manufacturers of brominated flame retardants to take certain risk management actions. Compliance with the VIC is on-going. Further actions include an investigation of the waste management practices in Member countries and the publication and updating of brominated flame retardants Hazard/Risk Information Sheets (UNEP, 2008e).

4.5 Lindane

4.5.1 Chemical and toxicological properties

The main characteristics of gamma-HCH are described in Table 7.

Table 7: Chemical identity and physico-chemical properties of γ-HCH.

Characteristic	γ-HCH
Structure	
IUPAC name	γ-1,2,3,4,5,6-hexachlorocyclohexane
Synonyms	Lindane; 1-alpha, 2-alpha, 3-beta, 4-alpha, 5-alpha, 6-beta-hexachlorocyclohexane; benzene hexachloridegamma-isomer; BHC; cyclohexane 1,2,3,4,5,6-hexachloro-gammaisomer; ENT 7796; gamma-benzene hexachloride; gamma-BHC; gammahexachlorocyclohexane; gamma1,2,3,4,5,6-hexachlorocyclohexane; gamma-HCH; gamma-lindane; HCH;HCCH; hexachlorocyclohexane, gamma-isomer; 1,2,3,4,5,6-hexachlorocyclohexane, gamma-isomer
Registered trade mark(s)	Etan 3G (Diachem S.P.A.); Forlin; Gamaphex; Isotox (Chevron Chemical Co.); Germate Plus (Gustafson Inc.); Gamma-Mean 400 and Gamma Mean L. (Oregon-California Chemicals, Inc.); Hammer (Exsin Industries); Lindagam; Novigam; Silvanol; Kwell (pharmaceutical shampoo/lotion)
Chemical formula	$C_6H_6Cl_6$
Molecular weight	290.83
Colour	White
Physical state	Crystalline solid, monoclinic prisms
Melting point	112.5 ºC
Boiling point	323.4 ºC at 760 mmHg
Density (g/cm^3)	1.89 at 19 ºC

Characteristic	γ-HCH
Water solubility	17 ppm to insoluble in water
Partition coefficient (Log K_{ow})	3.72
Vapour pressure	4.2x10-5 mmHg at 20 ºC

Source: ATSDR, 2005; UNEP, 2006a

Lindane has persistent, bioaccumulative and toxic properties. It has been found in samples around the world, and in human blood, human breast milk and human adipose tissue, especially in Artic communities, demonstrating its capacity for long range transportation in the atmosphere.

Studies show that at high doses, lindane can be neurotoxic, hepatoxic, immunotoxic and has been shown to have negative reproductive effects in laboratory animals. In addition, it is considered to have carcinogenic effects in humans (ATSDR, 2005, UNEP, 2007c)

4.5.2 Production and uses

The production of lindane is closely related to the production of technical HCH. This compound was introduced in the 1940s on a large scale on the market, due to its universal insecticidal properties, as an inexpensive alternative to DDT. However, the effectiveness of the mix of isomers that was technical HCH led to its replacement for lindane in a short period of time. The manufacture of lindane involves the photochlorination of benzene, and the fractional crystallization and concentration of the resulting mixture (technical HCH) to produce 99% pure lindane, with a roughly 10 to 15% yield (UNEP 2007a, UNEP 2007c). Therefore, for each ton of the gamma isomer (lindane), 6 to 10 tons of the other isomers are obtained as wastes, which have been mostly dumped over the last 50 years (IHPA, 2006).

According to the International HCH & Pesticide Association, historical production of technical HCH and lindane occurred in many European countries, including the Czech Republic, **Spain**, **France**, Germany, United Kingdom, **Italy**, Romania, Bulgaria, Poland, and **Turkey**, from 1950s to the 1990s. Other countries that have also produced these compounds were **Albania**, Argentina, Austria, Azerbaijan, Brazil, China, Ghana, Hungary, India, Japan, Russia, Slovakia and the United States. However, precise information is scattered and difficult to obtain, as the pesticide production records are, in many cases, inexistent, or the production companies do not provide the information as it is considered proprietary. In the last years, the production of lindane has decreased at a quick pace, being the only countries producing it India and possibly Russia, although the information is contradictory between different studies (IHPA, 2006).

This same report estimates the global lindane usage from 1950 to 2000 for several uses to around 600,000 tons, being Europe and Asia the mayor contributors to this figure, closely followed by America (IHPA, 2006).

Regarding the uses, has been used on a wide variety of fruit and vegetable crops through foliar applications, seed treatment, tree and wood treatment and against ectoparasites in both veterinary and human applications (head lice and scabies) (UNEP, 2006a; ATSDR, 2005). The only registered use left for lindane in 2006 was for seed treatment (barley, corn, oats, rye, sorghum, and wheat) and for pediculosis and lice and scabies treatment on humans in United States and Canada (USEPA, 2006; UNEP, 2006a). It was in that same year that the United States announced the cancellation of the remaining agricultural uses of Lindane, effective July 1, 2007, but kept registered the use for the treatment of lice and scabies once other treatments fail or cannot be tolerated by the patient (UNEP, 2007c).

4.5.3 Releases to the environment

The largest source of gamma-HCH releases to the **air** resulted from agricultural application of this pesticide or from volatilization after the application, although there were also releases arising from manufacturing industrial facilities. The erosion of contaminated soils may also distribute particles contaminated with this chemical to the atmosphere.

Releases to **surface water** of lindane can occur via surface runoff dissolved or adsorbed to particulates, or through wet deposition of rain and snow of particles suspended in the atmosphere. Lindane can reach **groundwater** via soil leachate although it has low mobility in soils.

Finally, gamma-HCH can be released to **soil** in the direct application of the pesticide to crops or by accidental releases in manufacturing or handling operations (ATSDR, 2005).

Figure 1 below shows a simplified life cycle of the lindane, from manufacturing to agricultural application and releases to the environment.

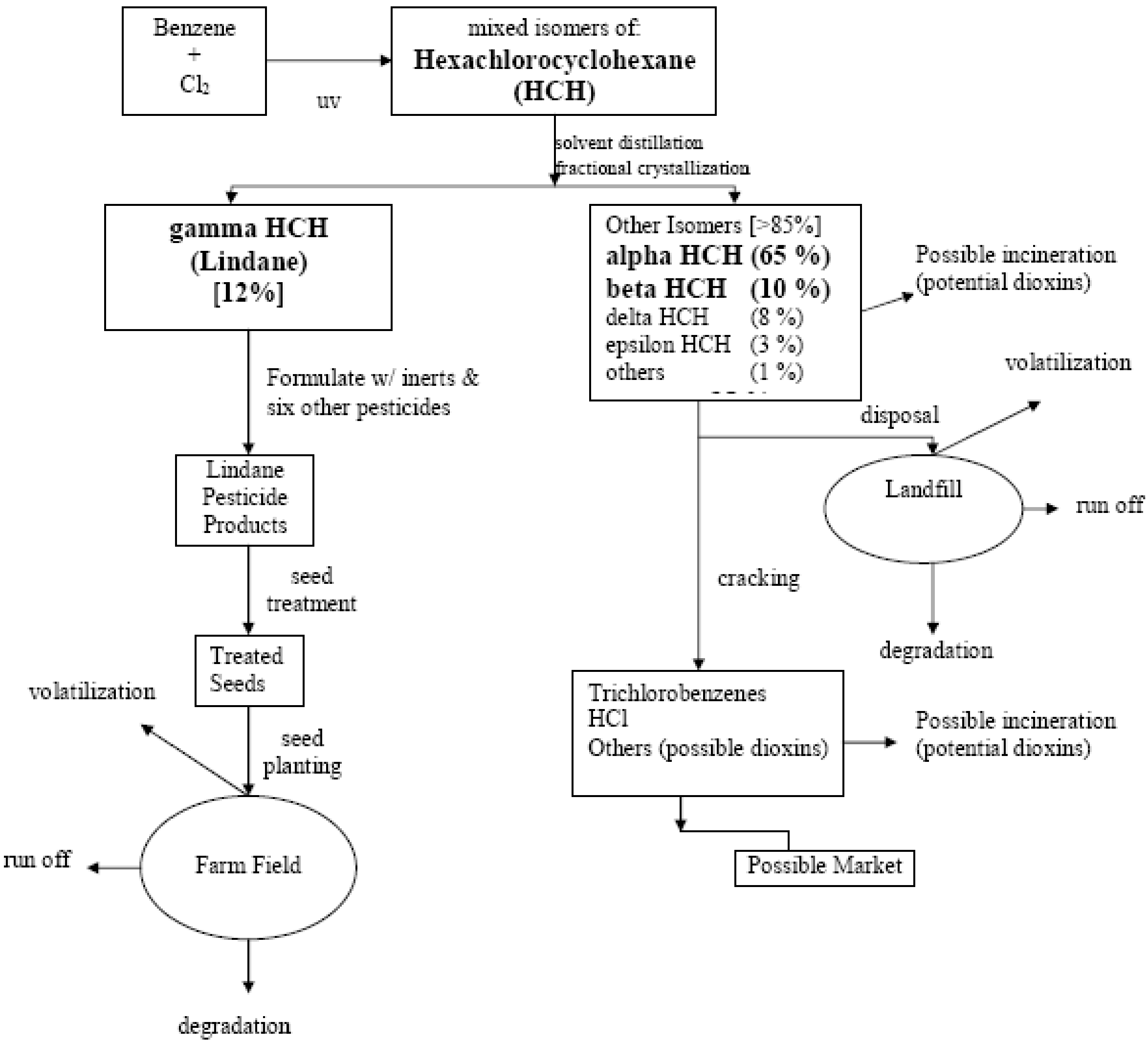


Figure 1: Lindane's life cycle. *Source: USEPA, 2006*

4.5.4 International framework and regulations

The Aarhus Protocol of the LRTAP Convention lists lindane as "substance scheduled for restrictions on use", restricting products in which more than 99% of the HCH isomers is lindane 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; and (6) indoor industrial and residential applications (UNECE, 1998)

Lindane, as the other alpha- and beta-HCH isomers, is listed in Annex III of the Rotterdam Convention on the Prior Informed Consent Procedure, as explained in section 3.3.1., and it is included in the List of Chemicals for Priority Action under the OSPAR Commission (updated in 2005).

Regarding regional initiatives, lindane is listed as Level II substance in the Great Lakes Binational Toxics Strategy between the Unites States and Canada. These two countries and Mexico are also developing a project on sound management of chemicals (the North American Regional Action Plan, NARAP), being lindane included (UNEP, 2007c).

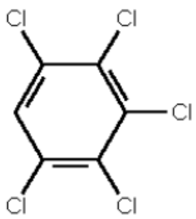
At a European level, lindane is listed under the Water Framework Directive (EC) 2000/60 as priority hazardous substance, which implies the setting of standards and emission controls at EU level. In addition, Regulation (EC) 850/2004 set a phase out limit for the production and use of lindane in 2007. Article 7 of the cited regulation sets isolated management measures that ensure the total destruction or irreversible transformation of wastes containing a sum of alpha-, beta- and gamma-HCH over 50 mg/kg. Disposal or recovery operations that may lead to recovery, recycling, reclamation or re-use of this mix of substances shall be also prohibited (European Commission, 2004).

4.6 Pentachlorobenzene

4.6.1 Chemical and toxicological properties

The main characteristics of gamma-HCH are described in Table 8:

Table 8: Chemical identity and physico-chemical properties of pentachlorobenzene.

Characteristic	Pentachlorobenzene
Structure	
IUPAC name	benzene, pentachloro-

Characteristic	Pentachlorobenzene
Synonyms	1,2,3,4,5-pentachlorobenzene; benzene, pentachloro-; quintochlorobenzene;PeCB
Registered trade mark(s)	-
CAS	608-93-5
Chemical formula	C_6HCl_5
Molecular weight	250.34 g/mol
Colour	Colourless to white
Physical state	Needles or crystalline solid
Melting point	86 ºC
Boiling point	277 ºC
Density	1.8 g/cm^3
Water solubility	0.135 – 3.46 mg/L at 24 ºC
Partition coefficient (Log K_{ow})	5.17 – 5.18
Vapour pressure	0.212 Pa at 25°C

Sources: UNEP, 2007d; UNEP, 2007e; UNEP, 2006b

According to these characteristics, and several peer-reviewed studies, pentachlorobenzene bioaccumulates in the food chain, is persistent in the environment and toxic to organisms, and has been proved to travel long distances through environmental compartments. However, environmental concentrations seem to be decreasing over time in the last decades.

4.6.2 Production and uses

In the past, pentachlorobenzene as well as trichlorobenzenes and tetrachlorobenzenes were used in transformers' dielectric fluids in combination with polychlorinated biphenyls (PCBs), in dyestuff carriers, and as a flame retardant. Since PCBs are still in use in some old electrical equipment in North America and some European countries, there is a small potential risk for release of PeCB from this source. There is a high probability that transformers with PCBs are still in use in developing countries, but with the increasing number of projects to the sound management of PCBs wastes, the releases of the containing PeCB are expected to decrease in time (UNEP, 2007d, Environment Canada, 2005).

The main current use of this substance is as a chemical intermediate in the manufacture of pentachloronitrobenzene (or quintozene), with fungicide properties (Environment Canada, 2005). As a consequence, PeCB is present in this fungicide as an impurity. However, the available data suggest that substitutes to PeCB have been found, and that the use of quintozene has been stopped in most UNECE countries. The situation in other regions of the world is unclear (UNEP, 2007d, UNEP, 2008c), but is expected the existence stockpiles of quintozene including impurities of PeCB (UNECE, 2007) that might be released into the environment without a proper management.

Traces of pentachlorobenzene can also be found in several other fungicides, herbicides and pesticides like endosulfan, chlorpyrifos-methyl, atrazine, and clopyrilid (Government of Canada, 1993; Environment Canada, 2005; UNEP, 2007d). In addition, technical grade hexachlorobenzene (already listed in annexes A and C of the Stockholm Convention) contains 1.8% of pentachlorobenzene (UNEP, 2007d).

In conclusion, according to the UNEP’s Risk Profile of Pentachlorobenzene, it is obvious that production and use of this substance in Europe and North America are negligible, but the situation in other parts of the world is less clear.

4.6.3 Releases to the environment

The main potential identified sources of releases to the environment of PeCB have been identified as: household waste burning activities, wood treatment plants and in service utility poles, pesticide use, dielectric fluid spill and cleanup, municipal solid waste incineration, hazardous waste incineration, magnesium production, solvent use and long range transport, combustion of coal, combustion of biomass, quintozene degradation, titanium dioxide production, and ore treatment for the production of metals including magnesium, copper, niobium, and tantalum.

Accurate data is available for Canada, and the main sources are, in decreasing importance: (1) barrel burning of household waste, (2) municipal solid waste incineration, (3) hazardous waste incineration and (4) magnesium production, being the first one clearly the major contributor. Other sources assign great importance to the combustion of biomass (Environment Canada, 2005; ICCA/WCC, 2007; UNEP, 2007d). PeCB has also been identified in waste streams from pulp and paper mills, iron and steel mills, petroleum refineries and activated sludge waste water treatment (Van de Plassche, E. *et al.*, 2002).

Total global emissions of PeCB have been estimated by the International Council of Chemical Associations/World Chlorine Council in year 2007 in 85 tons/year (ICCA/WCC, 2007).

In conclusion, although the available data is limited, it appears that at the global level, the most significant current source of pentachlorobenzene releases proceed from incomplete combustion of several types of fuel (waste, biomass…).

4.6.4 International framework and regulations

This substance, prior to the listing in the annexes of the Stockholm Convention, was not include in any international convention on chemicals management.

In December 2009, on the 27th session of the Executive Body of the Convention on Long-range Transboundary Air Pollution adopted decisions to amend the annexes of its Persistent Organic Pollutants Protocol, listing pentachlorobenzene to Annex I of the Protocol, as substance scheduled for elimination without any exemptions for production or use (ECE, 2010).

At a regional level, the European Water Framework Directive (2000/60/EC) identifies pentachlorobenzene as a priority substance, for being of particular concern for the fresh water, coastal and marine environment. Substances with this classification are required to be subject to cessation of discharges, emissions and losses within 20 years after the adoption of the Directive.

In addition, this substance is listed on the OSPAR's Commission 2002 List of Substances of Possible Concern, which replaced the 1998 List of Candidate Substances (UNEP, 2007d; ECE, 2010; OSPAR, 2010)

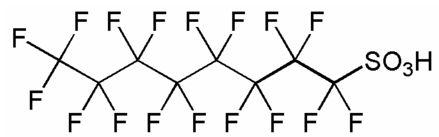
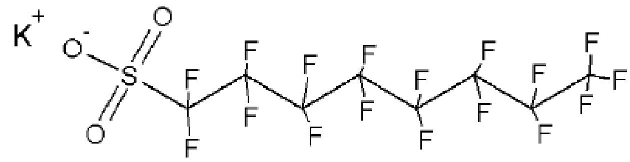
Other regional actions have been taken in Canada and United States, where pentachlorobenzene is identified as a Level II substance on the Great Lakes Binational Toxics Strategy under the Great Lakes Water Quality Agreement, aiming to the elimination from the Great Lakes Basin of toxic persistent substances, resulting from human activity (Van de Plassche, E. *et al.*, 2002).

4.7 Perfluorooctane sulfonic acid, its salts and Perfluorooctane sulfonyl fluoride

4.7.1 Chemical and toxicological properties

The main physico-chemical characteristics of these compounds are described in Table 9 below.

Table 9: Chemical identity and physico-chemical properties of PFOS potassium salt.

Characteristic	PFOS
Structure	Perfluorooctane sulfonate:  PFOS potassium salt: 
IUPAC name	-
Synonyms	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; Hepatadecafluoro-1-octanesulfonic acid; Perfluoro-n-octanesulfonic acid; Perfluorooctanesulfonic acid; Perfluorooctylsulfonic acid
Registered trade mark(s)	
CAS	Perfluorooctane Sulfonic acid: 1763-23-1[3] Potassium salt: 2795-39-3 Diethanolamine salt: 70225-14-8 Ammonium salt: 29081-56-9 Lithium salt: 29457-72-5

[3] Perfluorooctane sulfonate, as an anion, does not have a specific CAS number. The parent sulfonic acid has this recognised CAS number.

Characteristic	PFOS
Chemical formula	$C_8F_{17}SO_3^-$
Molecular weight	538 g/mol
Colour	White
Physical state	Powder
Melting point	> 400 ºC
Boiling point	Not measurable
Density (g/cm^3)	0.6
Water solubility	519 mg/L at 20 ºC
Partition coefficient (Log K_{ow})	Not measurable
Vapour pressure	3,31x10^{-4} Pa

Sources: OECD, 2002; UNEP, 2006c

In accordance with these characteristics, PFOS has been proved to be extremely persistent, since it has not showed degradation in tests of hydrolysis, photolysis or biodegradation at any environmental condition tested. The only know process that can degrade them is the incineration at high temperature. PFOS bioaccumulate in the food chain, with higher concentrations found in top predators like the polar bear, seal, bald eagle and mink. Its chemical properties show potential for long-range atmospheric transport, which has been evidenced through monitoring figures highly elevated in various parts of the northern hemisphere. Finally, PFOS has been demonstrated as toxic to mammals in subchronic doses at low concentrations and toxic to aquatic organisms (KEMI, 2005).

4.7.2 Production and uses

The company 3M was the major global producer of PFOS and PFOS-related substances prior 2000, through the electro-chemical fluorination process. PFOS-F is the reaction product of this process, and the primary intermediate for the production of PFOS and PFOS-relates chemicals. On 16 May 2000, 3M announced that the company would phase-out the manufacture of PFOS and PFOS-related substances voluntarily from 2001 onwards and in the beginning of 2003 the production ceased completely. This has been followed by a reaction within the relevant industry sectors to decrease the dependence of the industrial processes from these substances. However, there have been reported several plants located in Europe, Asia, Latin America and Japan still producing PFOS (UNEP, 2006c).

The following uses have been described in US, EU and UK (UNEP, 2006c; UNEP, 2007d):

- Fire fighting foams
- Carpets
- Leather/apparel
- Textiles/upholstery
- Paper and packaging
- Coatings and coating additives
- Industrial and household cleaning products
- Use of existing fire fighting foam stock
- Photographic industry
- Photolithography and semiconductor
- Hydraulic fluids
- Metal plating
- Minor uses as pesticides and insecticides, flame retardants, adhesives, medical applications and mining and oil surfactants

It can be assumed that the same uses apply worldwide, although actual information is not available.

Regarding the global quantities of PFOS used, information is scarce, and the last available data are only for US, with an estimated annual demand slightly higher than 12 tones/year.

The following Figure 2 presents the major PFOS product categories and their main uses.

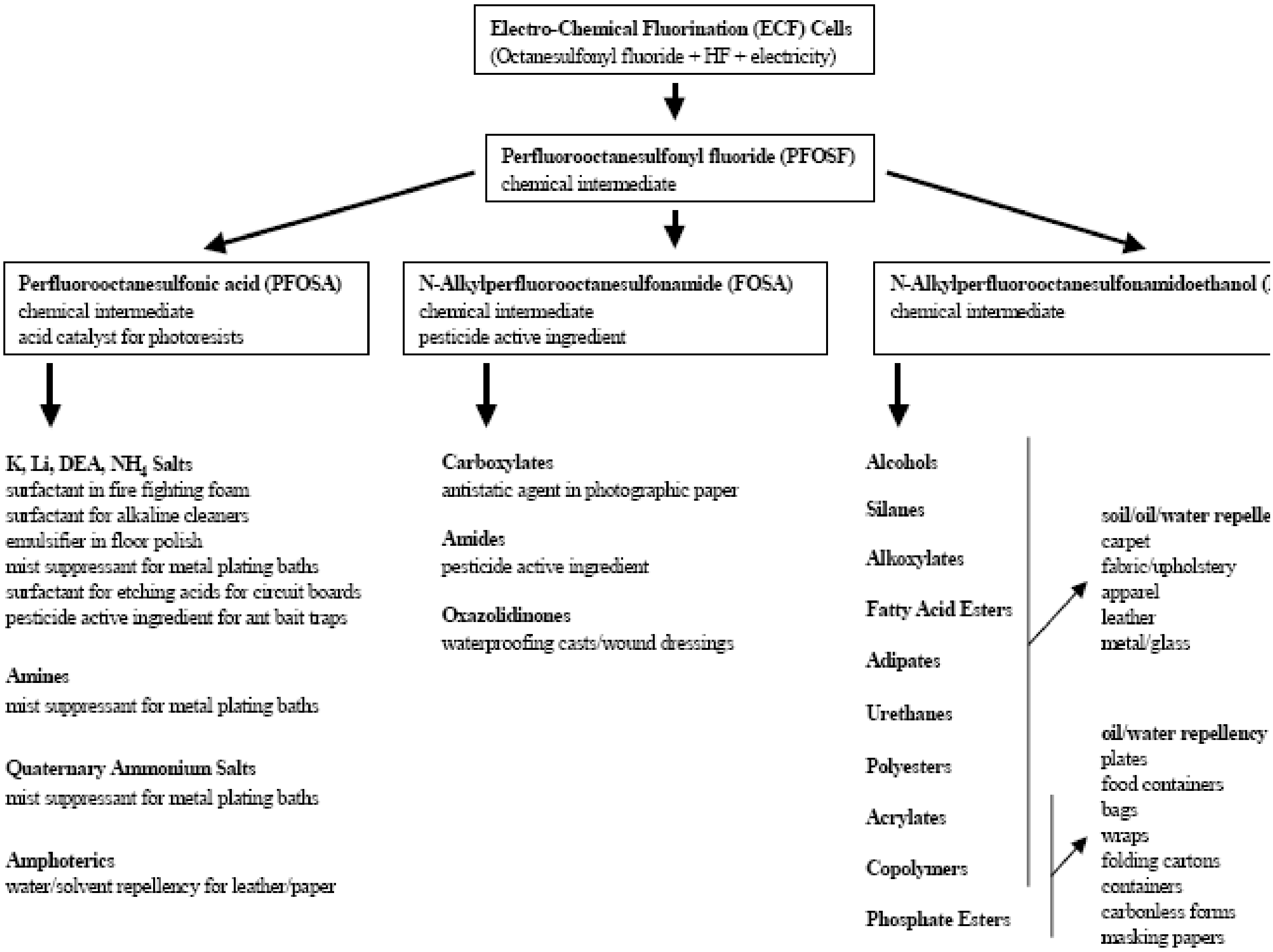


Figure 2: Major product categories of PFOS. *Source: OECD, 2002*

4.7.3 Releases to the environment

PFOS is a fluorinated anion commonly used as a salt or incorporated in larger polymers. They can be formed from PFOS-related substances, i.e., bigger molecules containing the PFOS-moiety. Several studies carried out by institutions like the US-EPA, the OECD, the OSPAR Commission, the Department of Environment from UK and Canada have identified between 50 to 170 PFOS-related substances that are thought to have the potential to break down to PFOS, as possible pollution sources (UNEP, 2006c).

PFOS is not a naturally occurring substance, so any presence in the environment has an anthropological origin. However, there is very limited information regarding the emissions and pathways of PFOS to the environment. Although manufacturing processes are considered to be the major source, releases are likely to occur during their whole life cycle to atmosphere, soil and superficial and groundwater. As expected, high concentration levels have been found close to the production facilities both in mice and fish. A relatively high concentration of this substance has also been measured close to fire training areas.

Releases of PFOS from different product usages have been estimated. For example, garments treated with home-applied products, are expected to lose 73 % of the treatment during cleaning over a 2-year life span. A loss of 34 % to air is expected from spray can products during use, while up to 12.5 % of the original content may be remaining in the cans at the time of disposal (UNEP, 2006c).

One of the biggest obstacles to the estimation of PFOS releases to the environment is that in addition to the direct releases, they can derivate from PFOS-related substances at rates and extents presently unknown.

4.7.4 International framework and regulations

In December 2009, on the 27th session of the Executive Body of the Convention on Long-range Transboundary Air Pollution adopted decisions to amend the annexes of its Persistent Organic Pollutants Protocol, listing PFOS to annex I of the Protocol, as substance scheduled for elimination from production and use and to annex II, as substance with restricted uses. The specified exemptions are the following uses and the production for this uses:

- Chromium electroplating, chromium anodizing and reverse etching until 2014.
- Electroless nickelpolytetrafluoroethylene plating until 2014.
- Etching of plastic substrates prior to their metalization until 2014.
- Photo-resist or anti-reflective coatings for photolithography processes.
- Photographic coatings applied to films, papers or printing plates.
- Mist suppressants for nondecorative hard chromium (VI) plating and wetting agents for use in controlled electroplating systems.
- Hydraulic fluids for aviation.
- Certain medical devices (such as ethylene tetrafluoroethylene copolymer ETFE) layers and radio-opaque ETFE production, in vitro diagnostic medical devices, and CCD colour filters).

In addition, they might be used for firefighting foams, but only if they have been manufactured or they were in use by 18 December 2009, and in any case their use shall cease by 2014 (ECE, 2010).

The OSPAR Commission added PFOS to the list of Chemicals for Priority Action in 2003 (UNEP, 2006c)

The European Union has adopted Directives 2006/122/EC and 76/769/EEC on restrictions on the use of PFOS. These substances shall be banned as substances or constituents of preparations in concentrations equal to or higher than 0.005%, in semi-finished products and articles at a level of 0.1% except for textiles or coated materials in which the restricted amount of PFOS will be 1 µg/m2. The exemptions provided are similar to the above mentioned by the LRTAP Protocol (UNEP, 2006c).

The US EPA has adopted the so-called Significant New Use Rules for 88 PFOS for manufacture and use. They 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 the specified ones, and have the authority to prohibit or limit this activity. The US EPA also implemented a phase-out of PFOS-related pesticide products containing sulfluramid, a substance that is manufactured using a PFOS derivative and can degrade to PFOS, or its lithium salt (UNEP, 2006c, UNEP, 2007d).

National regulations have also been identified in Australia and Canada with similar provisions to the ones specified in the LRTAP Protocol (UNEP, 2006c).

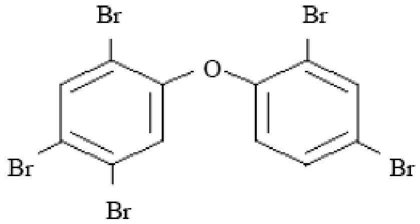
4.8 Tetrabromodiphenyl ether and pentabromodiphenyl ether

As it has already been stated, the Convention decided on listing tetraBDE and pentaBDE instead the commercial pentaBDE that was being assessed, since those two chemicals are main components of the commercial mixture. Therefore, this section will assess the characteristics of the commercial pentaBDE, although similar properties apply to the separate substances.

4.8.1 Chemical and toxicological properties

The main physico-chemical characteristics of these compounds are described in Table 10 below.

Table 10: Chemical identity and physico-chemical properties of PFOS potassium salt.

Characteristic	c-pentaBDE
Structure	
IUPAC name	Pentabromodiphenyl ether (diphenyl ether, pentabromo derivative)
Synonyms	Not available
Registered trade mark(s)	Not available
CAS	32534-81-9
Chemical formula	C_{12}H5Br_5O
Molecular weight	564.7
Colour	Amber (technical pentaBDE) White (pure pentaBDE)
Physical state	Viscous liquid or semi-solid at 20 ºC and 101.325 kPa (technical pentaBDE) Crystalline solid (pure pentaBDE)
Melting point	-7 to -3 ºC (commercial product)
Boiling point	Decomposes at >200 ºC (commercial product)
Density (g/cm^3)	2.25-2.28 (commercial product)
Water solubility	13.3 µg/l (commercial product) pentabromodiphenyl ether component = 2.4 µg/l tetrabromodiphenyl ether component = 10.9 µg/l
Partition coefficient (Log K_{ow})	6.57 (measured; commercial product) 7.88 (calculated)

Characteristic	c-pentaBDE
Vapour pressure	$4.69.10^{-5}$ Pa (commercial product)

Source: European Communities, 2001.

The available studies on c-pentaBDE are not concluding, but levels detected in humans and other species in the environment have been detected in monitoring studies in remote locations (indicating long range transport potential) and close to production and use sites. The physico-chemical properties of this substance suggest bioaccumulation potential in the fatty tissues of top predators, which also indicates biomagnification through the food chain.

Persistence varies among different environmental compartments, from 11-19 days in air to 600 days reported in aerobic sediment. Several biodegradation studies under different conditions have been carried out, resulting in low biodegradation levels.

Existent toxicological studies demonstrate relevant neurodevelopmental impacts in animals at low tissue levels compared to the average population, neurotoxicity, reproductive toxicity and effects on thyroid hormones. C-pentaBDE has shown to be more toxic than higher brominated congeners.

The phase out of c-pentaBDE production and use has led to a reduction in current use, but many articles existent in the market are slowly releasing this substance. Levels of pentaBDE in human blood and milk, and in other environmental species are falling in Europe, but they continue to increase in North America and the Artic region (UNEP, 2007k).

4.8.2 Production and uses

PentaBDE is synthesised from diphenyl ether by brominating it with elemental bromine in the presence of a powdered iron Friedel-Craft catalyst.

Based on information provided by the Bromine Science and Environmental Forum (BSEF), the estimated cumulative use of c-pentaBDE since 1970 was 100,000 metric tonnes. Data from 1999 and 2001 show a total marked demand from 7,500 to 8,500 tonnes/year worldwide.

According to several reportings, c-pentaBDE has been produced in Israel, Japan, United States and the European Union. However, since 2001 voluntarily phase-out of this substance has occurred in several countries. Production in EU ceased in 1997, and its use has been declining over the years. In the United States, the only manufacturer voluntarily ceased production in 2004. Production in Israel and Japan has been reported to have ceased.

C-pentaBDE is used, or has been used in the following sectors:

- Electrical and electronic 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, piples, 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.

The most common use, with 95 to 95% since 1999 has been in polyurethane foams for furniture and upholstery in domestic furnishing, automotive and aviation industry.

Although global demand of brominated flame retardants is expected to increase, lower brominated congeners like c-pentaBDE have been gradually substituted by compounds with higher bromination, such as decabromodiphenyl ether (UNEP, 2007k).

4.8.3 Releases to the environment

PentaBDE is released into the environment during several stages the life cycle of containing articles, from the manufacturing process of the actual chemical, in the manufacture of containing products, during their use and after they have been discarded as waste.

The producers of c-pentaBDE have reported that the major routes of losses to the environment during manufacturing are filter waste and rejected material, both of which are disposed of in landfills. The emissions in polyurethane production are assumed to occur prior to the foaming process, when handling the additives, causing discharges to water, and during curing, emitting to air. Estimations of emissions have been calculated in 0.6 kg of pentaBDE to waste water and 0.5 kg to air for each tonne of c-pentaBDE used in polyurethane foam production.

Emissions to the environment also occur during the containing product use, due to volatilization. Approximately 3.9% of the pentaBDE present in articles have been estimated to be released each year by this route.

While PentaBDE can volatilize from the products in which it is incorporated, as well as during their whole life-cycle, and during recycling or after disposal, a major route for dissemination of this chemical into the environment will be in the form of particles on which it is absorbed or adsorbed. When emitted from products, the flame retardants are likely to adsorb to particles, and these may adhere to surfaces within appliances or on other surfaces in the indoor environment, or they may spread to the outdoor environment during airing of rooms.

4.8.4 International framework and regulations

In December 2009, on the 27th session of the Executive Body of the Convention on Long-range Transboundary Air Pollution adopted decisions to amend the annexes of its Persistent Organic Pollutants Protocol, listing tetrabromodiphenyl ether and pentabromodiphenyl ether to Annex I of the Protocol, as substance scheduled for elimination without any exemptions for production and with the only exemption for use for recycling of articles that contain or may contain any of these substances, and the use and final disposal of articles manufactured from recycled materials that contain or may contain any of these substances, provided that the recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of any of these substances for the purpose of their reuse. Starting in 2013 and every four years the Executive Body shall evaluate the progress made towards the elimination, being 2030 the latest deadline (ECE, 2010). This inclusion implies, *de facto* the inclusion of c-pentaBDE since those two congeners are their main components.

Brominated flame retardants are included in the OSPAR's Commission List of Chemicals for Priority Action. C-pentaBDE is part of the List of Substances of Possible Concern, and although there are no specific measures targeting releases of brominated flame retardants, OSPAR has promoted activities related to them in the European Community, such as risk-reduction strategies and waste legislation for pentaBDE, among others.

The EU notified in 2003 the ban of pentaBDE to the Rotterdam Convention. For it to become a candidate substance to be included in Annex III, and thus, subject to the Prior Informed Consent procedure, bans of the substance must be notified by to parties under the Convention. According to the latest information available in the Convention's website, pentaBDE has not yet been listed to Annex III.

The Artic Council, a high level intergovernmental forum that provides a mechanism for addressing the common concerns and challenges faced by the Arctic governments and the people of the Arctic, carried out the Artic Monitoring and Assessment Programme (AMAP), and pentaBDE has been demonstrated to be one of the important pollutants of the Artic. Since 2004, a project developed by Norway aims towards the reduction of brominated flame retardants in the area.

National actions have been reported by Australia, EU, US, Japan, Norway, Canada and China, being most of them towards establishing restrictions in production or imports of articles (UNEP, 2007k; UNEP, 2007l)

5. Alternative chemicals

The best possible management strategy to minimize the risks of a hazardous substance is the substitution for less harmful alternative chemicals, but with similar effects in the required applications. Substitution should not be considered like a goal on its own, but the search of better solutions aiming not only to minimize risk for human health and the environment, but to options for optimizing product and cost efficiency of the manufacturing process. Thus substitution shows a twofold nature being both an instrument of environmental and health policy and an inherent component of business management on the other (IFQS, 2008).

Most commonly, the approach is to find a suitable chemical that achieves the intended technical purpose, but without the harmful effects. This section will focus mainly in the available options in the market to simply substitute the new chemicals listed to the annexes of the Stockholm Convention for other substances. However, it should be mentioned that in many cases there are other options involving earlier stages in the decision making process when tackling the problem of finding suitable alternatives to a certain chemical used for years in a certain process. These options would include changes to product design and materials, or finding non-chemical alternatives.

Substitution has been considered one of the principles of environmentalism, but still, there is no explicit mention of a “Substitution Principle” on international environmental instruments or declarations. It is, however, one of the strategies implemented by the Stockholm Convention or the OSPAR Convention. Chapter 19 of Agenda 21 recommends strengthening research on safe and safer alternatives to toxic chemicals and reducing risk by using other chemicals and non-chemical technologies. Both the Stockholm Convention, and Rotterdam Convention on Prior Informed Consent, among others, refer to the importance of informing, increasing awareness, and educating the public about alternative substances and technologies (IFQS, 2008).

The closest description of substitution on an international framework management of chemicals can be found in Art. 14 of the Overarching Policy Strategy (OPS) of the Strategic Approach to International Chemicals Management (SAICM):

> The objectives of the Strategic Approach with regard to risk reduction are:
>
> “(j)To promote and support the development and implementation of, and further innovation in, environmentally sound and safer alternatives, including cleaner production, informed substitution of chemicals of particular concern and non chemical alternatives.”

Substitution should also be understood in the context of Art. 14(d) of the OPS:

> "To ensure, [by 2020]:
>
> (i) That chemicals or chemical uses that pose an unreasonable and otherwise unmanageable risk to human health and the environment based on a science-based risk assessment and taking into account the costs and benefits as well as the availability of safer substitutes and their efficacy, are no longer produced or used for such uses;
>
> (ii) That risks from unintended releases of chemicals that pose an unreasonable and otherwise unmanageable risk to human health and the environment based on a science-based risk assessment and taking into account the costs and benefits, are minimized."

Recommendations on substitution should include a focus on performance and costs of alternatives, and possible use of incentives as options to encourage a transition, particularly to instigate an understanding of what societal tradeoffs are to be expected. Therefore, substitution is also a social process, which involves different actors and stakeholders (enterprises, different departments in enterprises, workers, business customers, private consumers, science, politics, authorities, environmental and consumer NGOs, financers, public and trade media, etc.).

A definition of substitution is found in Lohse J., Lißner L. *et al.*, 2003, as follows: "Substitution means the replacement or reduction of hazardous substances in products and processes by less hazardous or non-hazardous substances, or by achieving an equivalent functionality via technological or organisational measures."

IFQS, 2008 provides a more elaborated definition and enumerate the possible types of substitution:

"Substitution" means:

a) replacing a specific chemical by an alternative chemical substance to do the same task, and/or
b) replacing the technology, using a chemical, by a different technology using other means to do the same task.

"Alternative" means:

a) alternative substance, doing the same task as the original chemical, and/or
b) alternative technology, rendering the same service to the end user as the technology, using the original chemical.

Types of substitution:

a) full replacement of the chemical,

b) partial replacement of the chemical, depending on the reasons of substitution,

c) replacement by one single alternative, or

d) replacement by a variety of alternatives, according to the services, the original chemical substance is fulfilling.

In addition, the same document lists several reasons for a company to tackle the substitution of certain chemical:

a) the specific chemical used is hazardous,

b) the use of a specific chemical is hazardous, if the application of precautionary measures can not be guaranteed,

c) the specific chemical used is suspicious to be hazardous,

d) the specific chemical is expensive,

e) the technology, using a specific chemical, is expensive,

f) the safety measures, using a special chemical, are expensive,

g) there is a less hazardous alternative easy available and applicable,

h) internal management systems, external insurance providers, large customers or governmental regulations demand the use of the least or a less hazardous technology,

i) the specific chemical is technically not fully satisfying.

Frequently, there are barriers towards substitution clearly identified, particularly with regard to economic factors, technical functionality, communication and social factors. In several cases, there is a considerable imbalance between the available risk information on substances which have been found to be problematic and thus became subject to substitution efforts, and their potential substitutes for which less information is available. This lack of information is partly due to the fact that the substitute has never been used on a similar scale as the conventional substance, so performance data at industrial scale does not exist. Even where functionally equivalent substitutes are readily available, economically viable and proven to be less hazardous, their introduction in a certain process or product is often hampered by the fact that complex communication along the supply chain is a prerequisite for implementation.

On the other hand, risk information and regulatory framework set by legislation and standardisation are the most commonly found drivers in different substitution cases (Lohse J., Lißner L. et al., 2003).

This report will focus in finding alternatives or substitutes to traditionally used chemicals due to the new regulatory requirements after the inclusion of those substances in the annexes of the Stockholm Convention, which bans or restricts their production and/or use.

A detailed assessment for each one of the new chemicals listed in the Convention can be found in the following sections, but Table 11 displays a general overview on the availability of alternatives.

Table 11: Summary on availability of alternatives for the new POPs included in the Stockholm Convention.

Chemical	Listed in Annex	Availability of alternative
Alpha-hexachlorocyclohexane (α-HCH)	A	No alternatives. It's a by-product
Beta-hexachlorocyclohexane (β-HCH)	A	No alternatives. It's a by-product
Chlordecone	A	Yes
Hexabromobiphenyl (HBB)	A	Yes, for some uses
Hexabromodiphenyl ether and heptabromodiphenyl ether	A	Yes, for some uses
Lindane (γ-HCH)	A	Yes
Pentachlorobenzene (PeCB)	A & C	No. It's no longer used
Perfluorooctane sulfonic acid (PFOS) and its salts	B	Yes, for some uses
Perfluoroctane sulfonyl fluoride (PFOS-F)	B	Yes, for some uses
Tetrabromodiphenyl ether and pentabromodiphenyl ether	A	Yes, for some uses

Source: UNEP, 2009a.

5.1 Alpha- and beta-hexachlorocyclohexane

Alpha and beta isomers of HCH are by-products of the production of lindane, and have no registered uses (UNEP, 2008a).

Alternative processes for the production of lindane, that could lead to the reduction in the quantities of these two chemicals released have not been found during the bibliographic research (Vijgen, 2006 in UNEP, 2008a).

One possible management option reported by industry to reduce alpha- and beta-HCH residuals was to use them for the production of trichlorobenzene and hydrochloric acid, but this technique is obsolete, and has not been used since the 1970s (UNEP, 2008a).

Reports indicate that China and Russia still manufacture pentachlorophenol from hexachlorobenzene using the alpha-HCH residuals from lindane production, but this is not the only available processes for the manufacture of hexachlorobenzene (UNEP, 2008a), which indicates that the usage of alpha- and beta-HCH for this purpose might not be significant.

5.2 Chlordecone

The availability of alternatives has been reported by Canada, USA and **France** to the POPs Review Committee during the development of the Risk Management Evaluation for Chlordecone.

Alternatives used in USA are displayed in Table 12.

Table 12: Alternatives to chlordecone used in the USA.

Pest control	Alternative to chlordecone
Banana root borer	ethoprop, oxamyl
Tobacco wireworms	cyfluthrin, imidacloprid
Ants and/or cockroaches	azadirachtin, bifenthrin, boric acid, carbaryl, capsaicin, cypermethrin, cyfluthrin, deltamethrin, diazinon, dichlorvos, esfenvalerate, imidacloprid, lamda-cyhalothrin, malathion, permethrin, piperonyl butoxide, pyrethrins, pyriproxyfen, resmethrin, s-bioallerthrin, tetramethrin

Source: UNEP, 2007h.

In the **French Antilles**, when the use of chlordecone was banned, farmers used the following substances as substitutes: aldicarb, isophenphos, phenamiphos, cadusaphos and terbuphos. Some of these pesticides, like cadusaphos, have been reported to biodegrade within several weeks.

Algeria has developed measures to control the impact of pesticides, but the information available does not address to chlordecone in particular. These measures include preventive techniques (e.g. soil aeration), mechanical control techniques (e.g. raking), burning of weeds, use of antagonistic macro-organisms (insects, parasites, predator insects) and use of bio-insecticides and pesticides.

Alternatives to chlordecone also include non-chemical agro-ecological practices such as preventative pest management through appropriate fertility and field sanitation; the use and habitat enhancement of natural enemies; microbial preparations such as *Bacillus thuringiensis*; 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. These and other agro-ecological methods are being extensively and successfully practised in many countries, eliminating the need for chlordecone or other chemical interventions (UNEP, 2007h).

The available choices for substitution of chlordecone, according to the information compiled in the bibliographic research, seem to **fulfil the requirements of technical feasibility, efficacy, availability and accessibility**.

Information of **cost of the alternatives** compared to chlordecone has not been determined, but even in the hypothetic case of a higher initial purchase cost, when internalizing the cost associated to environmental and human health risk, it is likely that the use of alternatives is worthwhile.

5.3 Hexabromobiphenyl

As it has already been said in previous sections, production and use of HBB has probably ceased in most parts of the world, although it might still being produced and used in some developing countries or in countries with economies in transition. As most production and use has ceased, there are numerous alternatives available and in use (UNEP, 2007i).

Information on what articles used HBB as flame retardant is available for USA and Canada and have been described in section 4.3.2. It can be assumed that the same uses applied for the rest of the world, and the alternatives proposed focus on these uses.

Three possible approaches have been identified in finding substitutes for brominated flame retardants in general, that apply to HBB. The first one is the substitution of one flame retardant with another one, without changing the base polymer. In other cases, it is the plastic material containing the BFR what can be replaced by another plastic material. Finally, there is the option of replacing the plastic material with another material, or finding design alternatives that eliminate the need of using flame retardants (adapted from UNEP, 2007i)

Alternatives to HBB can be classified in alternative substances for the three main uses and alternative technologies:

5.3.1 Alternative substances

Alternatives to HBB in **ABS plastics** include organic phosphorous compounds, which can be halogenated or non-halogenated:

- Halogenated: tris-chloropropyl-phosphate (TCPP), tris-chloroethyl-phosphate, and tris dichloropropyl phosphate (TDCPP) (BMU, 2000).
- Non-halogenated: triphenyl phosphate (TPP), tricresyl phosphate (TCP), resorcinol bis(diphenylphosphate) (RDP), and phosphonic acid (2-((hydroxymethyl) carbamyl)ethyl)-dimethyl ester (Pyrovatex®) (Danish EPA, 1999).

Halogenated compounds have certain properties that argue against their commercial use. For instance TDCPP, TCPP and tri-chloroethyl phosphate entail moderate concern for carcinogenicity, reproductive toxicity, developmental toxicity, systemic toxicity, genotoxicity, acute and chronic ecotoxicity, and persistence (WHO, 1998; USEPA, 2005).

Non-halogenated organic phosphorus compounds as alternative flame retardants for High Impact Polystyrene (HIPS) and polycarbonate (PC) plastics include commonly used substances such as triphenyl phosphate (TPP), tricresyl phosphate (TCP), resorcinol bis(diphenylphosphate) (RDP), and phosphonic acid (2-((hydroxymethyl) carbamyl)ethyl)-dimethyl ester (Pyrovatex®) (Danish EPA, 1999 in UNEP, 2007i).

From those substances, TPP is considered to be hazardous for the environment in Germany due to its toxicity to aquatic organisms (BMU, 2000) and the US EPA reports moderate systemic toxicity and high acute and chronic ecotoxicity (USEPA, 2005). RDP is usually used in combination with TPP. Both reports BMU, 2000 and Danish

EPA, 1999 comment on the insufficiency of human and environmental toxicity data for RDP.

Tricresyl phosphate (TCP) toxicity apparently differs according to isomer: the ortho isomer is very toxic and potentially bioaccumulative. The mixture of isomers depends on the production method, particularly the cresols used as the starting material. Estimates indicate that current mixtures of tricresyl phosphate should contain less than 1% of the ortho isomer (IPEN, 2007b).

Information about Pyrovatex® is not conclusive, but different studies report harmful effects to the enzymatic system and chromosome mutations in high concentration (IPEN, 2007a).

The information retrieved indicates that, although there are available alternatives to BFRs in ABS plastics, all of them seem to have harmful effects to some extent, and further studies are needed to recommend a suitable alternative.

Regarding alternatives in the use of **coatings and lacquers**, aluminum trihydroxide is the most frequently used flame retardant (Danish EPA, 1999). It is reported to be highly effective and also suppresses smoke. Its functional disadvantage is that large amounts are required (up to 50%) which can affect the properties of the material. It would be extremely unlikely for its use in consumer products to cause adverse effects. Accumulation of the substance in food chains is not detectable (Danish EPA, 1999) and BMU, 2000 describes this alternative as “unproblematic”.

Magnesium hydroxide has comparable effects; however the environmental effects still have to be assessed (Danish EPA, 1999).

Zinc borate is often combined with aluminum trihydroxide and used to substitute for antimony trioxide. BMU, 2000 describes the teratogenicity of boron along with its ability to irritate the eyes, respiratory organs, and skin at high levels. However, this report assumes that its use as a flame retardant will not result in significant additional concentrations for humans, although it would be important to measure the ability for boron to be released in dust before its wide use in consumer products in homes (IPEN, 2007b).

For the third most common use of HBB, flame retardant in **polyurethane foams** ammonium polyphosphate (APP) is an additive flame retardant currently used to flame retard flexible and rigid polyurethane foams, as well as intumescent laminations (those which swell on heating and thus provide some measure of flame retardancy), moulding resins, sealants and glues. APP formulations account for approximately 4-10% in flexible foam, and 20-45% in rigid foam (USEPA, 2005 in UNEP, 2007i). APP is commonly used in combination with aluminium hydroxide and melamine. It metabolizes into ammonia and phosphate and is not thought to cause acute toxicity in humans (BMU, 2000). However, there are no analyses of long-term toxicity, teratogenicity, mutagenicity, or carcinogenicity. APP breaks down rapidly and does not accumulate in the food chain. However, skin irritation is possible due to the formation of phosphoric acids.

Red phosphorous has been used mainly in polyamides, but is easily ignited and poorly characterized toxicologically, with inexistent data on ecotoxicity, carcinogenicity, mutagenicity, long-term toxicity, or toxicokinetics. Ecosystem accumulation is thought to be unlikely (BMU, 2000). For these reasons, the use of this alternative is not recommended for smaller plastic producers (Danish EPA, 1999 in UNEP, 2007i).

Melamine and its derivates (cyanurate, polyphosphate) are used in flexible polyurethane foams, intumescent coatings, polyamides and thermoplastic polyurethanes. They are used effectively in Europe in high-density flexible polyurethane foams but require 30 to 40 percent melamine per weight of the polyol (UNEP, 2007i).

These compounds display several toxic effects in rainbow trout eggs, snails and houseflies. In addition, in a fire, melamine cyanurate will release toxic fumes such as hydrocyanic acid and isocyanate. However, according to the Danish EPA, no adverse effects are envisaged from the level of exposure expected from the use of melamine as a flame retardant. In contrast, the report from the German Ministry of Environment describes this substance as problematic (IPEN, 2007b).

5.3.2 Alternative technologies

Currently available options for the reduction of the use of BFRs include barrier technologies and graphite impregnated foam.

Barrier technologies involve the application of layers of materials that provide fire resistance, such as boric acid-treated cotton materials, used in mattresses; blends of natural and synthetic fibres used in furniture and mattresses (VISIL, Basofil, Polybenzimidazole, KEVLAR, NOMEX and fibreglass), and high performance synthetic materials used in fire-fighter uniforms and space suits (IPEN, 2007b). Barrier technologies using cotton and boric acid appear to offer a flame retardant system commercially available and affordable (IPEN, 2007b), but potential effects of boron should be taken into account and it would be important to measure the ability for boron to be released in dust before its wide use in consumer products in homes (BMU, 2000).

Graphite impregnated foam (GIF) and surface treatments have limited commercial uses. GIF can be considered an “inherently flame-resistant foam” that is self-extinguishing and highly resistant to combustion. It is a relatively new technology and is largely used in niche markets such as for general aircraft seating. Surface treatments are also used in some applications and niche markets and may be appropriate for some textile and furniture manufacturing. However, surface treatments may not be viable as industry-wide replacements for use in low-density foam (USEPA 2005 in UNEP, 2007i).

Regarding the **technical feasibility** of both types of alternatives, all of them have been reported to be technically feasible and have been used in commercial applications. For this same reason, they fulfil the requirements of **availability** and **accessibility** (IPEN, 2007b), although it should be noted that the fact that many alternatives are in commercial use does not necessarily mean they are available globally (UNEP, 2007i).

When tackling the **efficacy** of the alternatives, comments have been found on ammonium polyphosphate, which chemical manufacturers and foam manufacturing trade groups do not consider to be an alternative for brominated flame retardants on a large scale. Reasons for this are that APP is typically incorporated as a solid, it has adverse effects on foam properties and processing and it is not considered to be as effective as a fire retardant compared to other alternatives (USEPA, 2005 in UNEP, 2007i).

Melamine and TDCPP as two of the most commonly used chemicals to flame retard high-density, flexible polyurethane foam either result in scorching of the foam (an aesthetic effect unless severe) or a negative effect on the physical properties of foam if used in low-density flexible foams. Also, many formulations of these chemicals are available only as solids; making them less desirable as drop in substitutes for some brominated flame retardants (USEPA, 2005 in UNEP, 2007i).

With regard to the **cost of the alternatives** their prices are in general not higher than the BFRs but many times higher loading is necessary. This is in particular true with respect to the inorganic compounds aluminum trihydroxide and magnesium hydroxide. Due to the low price of aluminum trihydroxide alternative materials may not be more expensive than BFR containing materials, but magnesium containing materials will usually be significantly more expensive due to the higher dose needed to achieve a similar effect (Danish EPA, 1999). However, according to IPEN, there are important points to consider when evaluating the costs of alternatives for any product (IPEN, 2007b):

- Alternatives with a higher initial purchase cost may actually be more cost effective over the life of the product when durability and other factors are taken into account.
- Mass-production of alternatives can significantly lower their costs.
- The costs of initiatives to protect health and the environment are frequently overestimated in advance and later decline rapidly after the regulation is implemented.

As concerns alternative technologies, the US EPA describes the boric acid-treated cotton as "… the least expensive flame-retardant barrier materials available." However, also GIF modified foams can be priced competitively by minimizing the expense associated with flame-retardant fabric (USEPA, 2005).

5.4 Hexa and heptaBDE[4]

As it was mentioned in previous sections of the report, the substance known as commercial octabromodiphenyl ether is a mixture of several polydiphenyl ethers, mainly hexa- and heptabromodiphenyl ether. The alternatives suggested in this section will be addressed to the commercial mixture available in the market as final product.

The phasing out of c-octaBDE is undergoing. According to the information available, EU, USA and Canada have stopped the production of this chemical and voluntary phase out by industry is underway in Japan. After the ban and phase out of c-octaBDE in 2004 in the European Union, the availability of practicable and economically viable substitutes has already been demonstrated in practice. On the other hand, design changes can eliminate the need for flame retardants by using alternative materials or designs that remove the need for chemical flame retardants.

Several chemical alternatives have been reported for the different uses of c-octaBDE as fire retardant.

For the substitution of this chemical in **ABS plastic applications**, potential alternatives identified include tetrabromobisphenol-A (TBBPA), 1,2-bis(pentabromophenoxy) ethane, 1,2-bis(tribromophenoxy) ethane, triphenyl phosphate, resourcinol bis (diphenylphosphate) and brominated polystyrene.

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[4] Information for this section, if not otherwise stated, has been compiled from UNEP, 2008e.

In ABS, TBBPA and brominated epoxy oligomers are used as additive flame retardants. Therefore, they are not bound to the polymer and have a greater tendency to be released to the environment. TBBPA is a cytotoxicant, immunotoxicant, and thyroid hormone agonist with the potential to disrupt estrogen signaling. TBBPA is classified as very toxic to aquatic organisms and is on the OSPAR Commission’s List of Chemicals for Priority Action due to its persistence and toxicity. To avoid their use in ABS applications, poly (phenylene oxide) / high impact polystyrene (PPO / HIPS) blends flame retarded with resorcinol diphosphate (RDP) have been proposed.

The US EPA lists triaryl phosphate and an isopropylated derivative as having moderate bioaccumulation properties based on structure activity relationships (USEPA, 2005).

Bis (tribromophenoxy) ethane is poorly characterized. Studies by its manufacturer indicate low toxicity, but the substance tends to persist and bioaccumulate

For its use in **synthetic textiles**, alternatives to c-octaBDE include reactive phosphorous constituents and hexabromocyclododecane.

Polyglycol esters of methyl phosphonic acid have been used as flame retardants in **polyurethane foam**, and applications for textile fabrics are possible. Methyl phosphonic is reported to have significance persistence, but does not appear to be bioaccumulative. Other types of reported toxicity are minimal, but the substance reacts violently with water.

Hexabromocyclododecane (HBCD) is used as an additive flame retardant indicating that it is not bound to the polymer and therefore has a greater tendency to be released to the environment. HBCD is bioaccumulative, persistent, and causes neurobehavioral alterations in vitro.

C-octaBDE has also been used in **thermoplastic elastomers**, and chemical substitutes include bis (tribromophenoxy) ethane and tribromophenyl allyl ether (Danish EPA, 1999). The first substance has already been discussed in previous paragraphs, and regarding tribromophenyl allyl ether, the information available is limited.

Chemical substitutes for c-octaBDE in **polyolefins** include polypropylene-dibromostyrene, dibromostyrene, and tetrabromobisphenol A. TBBPA is described above and few data are available for dibromostyrene and polypropylene-dibromostyrene. For dibromostyrene, an EU assessment found insufficient information on toxicity, no bioaccumulation based on a low BCF value, and overall persistence of 49 days based on modelling.

All the suggested alternative substances are **technically feasible** and have been used for years in commercial applications. Most companies have already replaced octaBDE with other chemicals or are using design measures. Overall, there does not seem to be any major technical obstacle to replacement of the substance, but some of the combinations considered may have inferior technical performance in certain applications. Many companies, like Dell, Lenovo, LG Electronics, IBM, Ericsson, Apple, Matsushita (including Panasonic), Intel, or B&O have already implemented alternatives to c-octaBDE or have agreed to do it in the near future.

5.5 Lindane

Lindane has been used as a pesticide in agriculture, and for pharmaceutical uses in animals and humans.

Lindane is banned for use in at least 52 countries (IPEN, 2007c) so the related industry has been developing alternative substances or techniques for years and there is a wide variety of chemical and non-chemical alternatives available in the market.

For a better compilation of reported alternatives used in different countries, the full list of chemical substitutes is gathered in Table 13.

Table 13: Alternatives to lindane used by country.

Country	Use	Alternative to lindane
United States	Seed treatment for corn, barley, wheat, oat, rye and sorghum	Clothianidin, Thiamethoxam, Imidacloprid, Permethrin and Tefluthrin
	Livestock treatment	Amitraz, Carbaryl, Coumaphos, Cyfluthrin, Cypermethrin, Diazinon, Dichlorvos, Fenvalerate, Lambda-cyhalothrin, Malathion, Methoxychlor, Permethrin, Phosmet, Pyrethrin, Tetrachlorvinfos, and Trichlorfon
	Veterinary drugs	Eprinomectin, Ivermectin, Doramectin, Moxidectin, and Methoprene

Country	Use	Alternative to lindane
	Pharmaceutical use (treatment for head lice)	Pyrethrum/Piperonyl butoxide, Permethrin, and Malathion. Lice nit combs are also recommended for use in conjunction with these treatments.
	Pharmaceutical use (treatment for scabies)	Permethrin and Crotamiton (Eurax)
Canada	Pharmaceutical use	Permethrin (1% cream), Bioallethrin and piperonyl butoxide, Pyrethrin and piperonyl butoxide, Permethrin (5% cream), Precipitatedisulphur 6% in petrolatum and Crotamiton 10% (Eurax)
	Agricultural use (canola)	Acetamiprid, Clothianidin, Thiamethoxam and Imidacloprid; for corn: Clothianidin, Imidacloprid (only for field corn grown for seed) and Tefluthrin
	Agricultural use (sorghum)	Thiamethoxam and Imidacloprid
	Livestock treatment	Carbaryl, Diazinon, Dichlorvos, Malathion, Phosmet, Tetrachlorvinphos, Trichlorfon, Cyfluthrin, Cypermethrin, Fenvalerate, Permethrin, Pyrethrin, Rotenone, Eprinomectin, Evermectin, Abamectin, Doramectin, Moxidectin and Phosmet
Republic of Zambia	Agricultural use (canola)	Gaucho, Helix and Primer-Z
	Pharmaceutical use (treatment for head lice)	Nix
Germany	Against *Atomaria linearis*	Thiamethoxam, Imidacloprid, Imidacloprid / Tefluthrin, Clothianidin, Clothianidin / Beta-Cyfluthrin, Alpha-Cypermethrin and Deltamethrin
	Against *Elateridae*	Clothianidin, Imidacloprid and Thiamethoxam

Country	Use	Alternative to lindane
	Against leaf-cutting insects	Lambda-Cyhalothrin, Acadirachtin, Pyrethrin / Rapsöl, Beta-Cyfluthrin, Alpha-Cypermethrin, Lambda-Cyhalothrin, Acadirachtin, Pyrethrin / Rapsöl and Methamidophos
	Wood protection	3-Iodo-2-propynyl butylcarbamate (IPBC), (E)-1-(2-Chloro-1,3-thiazol-5-ylmethyl)-3-methyl-2-nitro guanidine / Clothianidin, 1-(4-(2-Chloro-alpha,alpha,alpha-p-trifluorotolyloxy)-2-fluorophenyl)-3-(2,6-difluorobenzolyl)urea / Flufenoxuron, Cyclopropanecarboxylic acid, 3-[(1Z)-2-chloro-3,3,3-trifluoro-1-propenyl]-2,2-dimethyl-, (2-methyl[1,1'-biphenyl]-3-ylmethyl ester, (1R,3R)-rel- / Bifenthrin, 3-Phenoxybenzyl-2-(4-ethoxyphenyl)-2-methylpropylether / Etofenprox, m-Phenoxybenzyl 3-(2,2-dichlorovinyl)-2,2-dimethylcyclo propanecarboxylate / Permethrin, alpha.-cyano-3-phenoxybenzyl 3-(2,2-dichlorovinyl)-2,2-dimethylcyclo propanecarboxylate / Cypermethrin, Dazomet, Thiamethoxam and 4-Bromo-2-(4-chlorophenyl)-1-(ethoxymethyl)-5-(trifluoromethyl)-1H-pyrrole-3-carbonitrile / Chlorfenapyr
	Veterinary topical insecticide	Infectopedicul solution (Permethrin)
Thailand	Pharmaceutical use (treatment for head lice and scabies)	Permethrin, Cabaryl, Stemona root extract and benzyl benzoate
	Veterinary use	Permethrin, Flumethrin and Cypermethrin
	Termite control	Alpha-cypermethrin, Bifenthrin, Cypermethrin and Delta-methrin

Country	Use	Alternative to lindane
China	Locust control	Organophosphorous and pyrethroid pesticides, i.e. malathion and cypermethrin., fipronil on a limited basis.
Sweden	Pharmaceutical use (treatment for head lice and scabies)	Malation, Permethrin and Disulfiram with bezylbenzoate
	Veterinary use	Flumethrin, Foxim, Fipronil, Ivermectin and Moxidectin
Brazil	Termite and drill control	Cypermethrin, Deltamethrin, Fipronil
	Wood protection	Cypermethrin and 3-iodo-2-propynyl butylcarbamate (IPBC), Cyfluthrin, TBP
Switzerland	Seed treatment	Fipronil and Thiamethoxam
South Africa	Pharmaceutical use (treatment for head lice and scabies)	Benzyl Benzoate (25%)

Source: Several sources compiled in UNEP, 2007c.

Besides the chemical alternatives for direct substitution of one chemical for another enumerated above, there are non-chemical alternatives described in the bibliography that have been used mainly for the agricultural applications of lindane, such as cultural and biological methods.

Among **cultural methods** currently known to effectively prevent harm to seeds and crops are (CEC, 2006 in UNEP, 2007c):

- Crop rotation (alfalfa, soybeans and clover), where small grains need to be rotated with a non-host species every year to reduce the severity of infestation and maintain low levels of pests.
- Site selection and monitoring in order to determine if wireworms are present.
- Fallowing, starving wireworms by allowing the area to fallow for a few years before planting.
- Re-seeding with resistant crops such as buckwheat or flax.

- Timing of seeding and planting, trying to plant in warm, dry conditions, usually later in the season for small grains where larvae are deeper in the soil and giving seedlings a greater chance of survival.
- Shallow cultivation to starve hatchlings, expose eggs for predation and damage larvae.
- Soil packing to impede wireworm travel.

Biological methods have also been proved with success, and others are under evaluation. Canada has examined the use of *Metarhizium anisopliae* (an insect fungal pathogen) to control wireworm. The research demonstrates that "microbials can be effective seed treatments" and may be particularly effective when combining Metarhizium with neonicotinoid treatments. Additional research with another microbial, Tricoderma (T-22), has also demonstrated effective results. Costa Rica has reported that *Metarhizium* and other biological controls are registered in the country as alternatives in commercial products for use on wireworms and for the treatment of seeds, potatoes and other vegetables, sugar cane and cantaloupe. Additionally, other control methods used in Costa Rica are based in *Trichodama spp, Piper aduncum, Trichogram wasps*, and *Bacillus thuringiensis*. In China, although the use of lindane for locust control is allowed, biological alternatives are being strongly promoted by the Chinese government. These include locust microsporidium, metarrhizium anisopliae and nimbin. However, based on the assessment of relevant authorities, Lindane is still the best pesticide to control Locust in the case of extensive outbreaks (IPEN, 2007c; UNEP, 2007c).

Non-chemical alternatives for the treatment of head lice and scabies have been discussed by several authors. For the treatment of head lice the application of hot air for 30 minutes showed results of nearly 100% mortality of eggs and 80% mortality of hatched lice, with no adverse effects. For scabies treatment, some authors suggest that essential oils have shown positive effects against mites in vitro and in field studies. Tea tree oil (*Melaleuca alternifolia*) and a paste made from extracts of neem (*Azadirachta indica*) and tumeric (*Curcuma longa*) are considered highly effective. In a clinical trial in Nigeria, bush tea (*Lippia multiflora*) essential oil showed similarly high cure rates. A randomized control study in Brazil showed a commercially available repellent containing coconut oil and jojoba was highly effective (IPEN, 2007c).

Regarding the **technical feasibility** of the suggested alternatives, in the case of seed and livestock treatments and pharmaceutical use, reports state that they are in use and feasible from a technical point of view. in Canada, technical feasibility is a condition for the registration of alternatives, so the ones used in that country comply with this requirement. In Sweden, alternatives are all technically feasible, available, freely accessible and effective if used as prescribed (UNEP, 2007c).

With regard to the **cost of the alternatives**, information is available from the United States. The use of Imidacloprid and Thiamethoxam for the treatment of wheat, barley, oats, rye, corn, and sorghum seeds was as effective of lindane, but costlier to use, with an estimated cost increase ranging from $0.36 to $4.69 per acre, or from 0.04 to 0.06% of total US crop value (USEPA, 2006).

For pharmaceutical uses, lindane is not used for human in the South African public health care sector as the alternatives are cheaper such as 25% Benzyl Benzoate and reduce risk to vulnerable populations (UNEP, 2007c).

Respecting the **efficacy of the alternatives**, slightly worse performance results have been described in the United States and Thailand (UNEP, 2007c).

Availability and **accessibility** of the alternatives above described has been granted in several countries. They are in the market and many of them already in use.

5.6 Pentachlorobenzene

There is no reported current market demand of PeCB worldwide, and its only use is as intermediate in the production of the fungicide quintozene. Therefore, alternatives for this substance are not needed.

There is, however, an alternative process for the production of quintozene, which involves the chlorination of nitrobenzene and prevents the use of PeCB (UNEP, 2008c). This production process has been used at least since 2002 (Van de Plassche, E. *et al.*, 2002), so it can be assumed that results at industrial level are satisfactory.

5.7 Tetrabromodiphenyl ether and pentabromodiphenyl ether

As it was mentioned in previous sections of the report, the substance known as commercial pentabromodiphenyl ether is a mixture of several polydiphenyl ethers, mainly tetra- and pentabromodiphenyl ether. The alternatives suggested in this section will be addressed to the commercial mixture available in the market as final product.

With the phasing out of c-pentaBDE, manufacturers have been identifying and using several alternatives. In addition, several governments and large corporations have developed green procurement guidelines that prohibit the use of PBDEs in electronic products (UNEP, 2007l).

As in the case of the HBB, two approaches are possible: alternative chemicals and alternative processes or technologies. The alternative technologies described in section 5.3.2 are totally valid for certain uses of the c-pentaBDE. In this section will be discussed the alternative chemicals for the several uses given to c-pentaBDE over the years.

The most common use of c-pentaBDE has been as flame retardant in **polyurethane foam** (PUR) (UNEP, 2007k). The US EPA has established a Furniture Flame Retardancy Partnership to identify, with relevant stakeholders, environmentally safer chemical alternatives to this substance. Leading US flame-retardant chemical manufacturers identified 14 chemical formulations that are viable substitutes for c-pentaBDE in large-scale production of low-density flexible polyurethane foam, reproduced in Table 14:

Table 14: Alternative Flame-Retardant Chemical Formulations

Albemarle Corporation	Ameribrom, Inc. (ICL Industrial Products)	Great Lakes Chemical Corporation	Supresta (Akzo Nobel)
SAYTEX® RX-8500 Proprietary reactive brominated flame retardant, proprietary aryl phosphate, triphenyl phosphate CAS 115-86-6	FR 513 Tribromoneopentyl alcohol CAS 36483-57-5	Firemaster® 550 Proprietary halogenated aryl esters, proprietary triaryl phosphate isopropylated, triphenyl phosphate	Fyrol® FR-2 Trs(1,3-dichloro-2-propyl) phosphate CAS 13674-87-8
SAYTEX® RZ-243 Proprietary tetrabromophthalate, proprietary aryl phosphate, triphenyl phosphate		Firemaster® 552 Proprietary halogenated aryl esters, proprietary triaryl phosphate isopropylated, triphenyl phosphate	AB053 Tris(1,3-dichloro-2-propyl) phosphate
ANTIBLAZE® 195 Tris(1,3-dichloro-2-propyl) phosphate CAS 13674-87-8			AC003 Proprietary organic phosphate ester, triphenyl phosphate
ANTIBLAZE ® 205 Proprietary chloroalkyl phosphate, aryl phosphate and triphenyl phosphate			AC073 Proprietary aryl phosphates, triphenyl phosphate
ANTIBLAZE® 180 Tris(1,3-dichloro-propyl) phosphate CAS 13674-87-8			
ANTIBLAZE® V-500 Proprietary chloroalkyl phosphate, aryl phosphate and triphenyl			

Albemarle Corporation	Ameribrom, Inc. (ICL Industrial Products)	Great Lakes Chemical Corporation	Supresta (Akzo Nobel)
phosphate			
ANTIBLAZE® 182 Proprietary chloroalkyl phosphate, aryl phosphate and triphenyl phosphate			

Source: UNEP, 2007e.

These identified alternatives are suitable replacements for c-pentaBDE, compatible with existent processes and equipment at foam manufacturing facilities, and therefore cost-effective (UNEP, 2007l).

Three of the most commonly used chemicals that various reports have suggested may be more environmental and viable alternatives to c-pentaBDE are melamine, tris (1,3-dichloro-2-propyl) phosphate (TDCPP) (or TCPP) and ammonium polyphosphate (APP). Flame retardants based on melamine are currently used in flexible polyurethane foams, intumescent coatings, polyamides and thermoplastic polyurethanes.

TDCPP is a chlorinated phosphate ester that is often used in polyurethane foam formulations. It is used in high-density foam and has been used in low-density foams when light scorching (discoloration) is not a primary concern.

APP, an additive flame retardant, is currently used to provide flame retardancy in flexible and rigid polyurethane foams, as well as in intumescent laminations, moulding resins, sealants and glues. However, chemical manufacturers and foam manufacturing trade groups do not consider it to be an alternative for c-pentaBDE on a large scale (UNEP, 2007l), as it has already been said in previous sections.

According to IPEN, 12 of these substances have a moderate or high concern for persistence or would produce persistent degradation products. An additional 6 substances have a moderate concern for the ability to bioaccumulate, as shown in Table 15. Hence, substitution of these products for pentaBDE would substitute one persistent, bioaccumulative substance for another. For this reason, these products would not be appropriate for replacing pentaBDE (IPEN, 2007a).

Table 15: Persistent and bioaccumulative properties of pentaBDE alternatives for use in polyurethane foam described by USEPA

Persistence (moderate, high, or persistent degradation products expected)	Albemarle Antiblaze 180 and 195 Tris (1,3-dichloro-2-propyl) phosphate CAS 13674-87-8 Albemarle Antiblaze 182 and 205 Proprietary A chloroalkyl phosphate Albemarle Antiblaze V500 Proprietary C chloroakyl phosphate Albemarle Saytex RX-8500 Proprietary D reactive brominated flame retardant b Albemarle Saytex RZ-243 Proprietary E tetrabromophthalate diol diester Great Lakes Firemaster 550 Proprietary F Halogenated aryl ester Great Lakes Firemaster 550 Proprietary H halogenated aryl ester Great Lakes Firemaster 552 Proprietary F halogenated aryl ester Great Lakes Firemaster 552 Proprietary H halogenated aryl ester Supresta AB053 Tris (1,3-dichloro-2-propyl) phosphate CAS 13674-87-8 Supresta AC003 Propietary I organic phosphate ester Supresta Fyrol FR-2 Tris (1,3-dichloro-2-propyl) phosphate CAS 13674-87-8
Bioaccumulation (moderate)	Albemarle Antiblaze 182 and 205 Proprietary B aryl phosphate Albemarle Antiblaze V500 Proprietary B aryl phosphate Albemarle Saytex RX-8500 Proprietary B Aryl phosphate Albemarle Saytex RZ-243 Proprietary B Aryl phosphate Great Lakes Firemaster 550 Proprietary G triaryl phosphate CAS 115-86-6 Great Lakes Firemaster 552 Proprietary G triaryl phosphate isopropylated

Source: IPEN, 2007a.

An examination of the remaining products/substances shows that many utilize triphenyl phosphate which raises moderate concerns for systemic toxicity and high acute and chronic ecotoxicity.

Tribromoneopentyl alcohol used in Ameribrom FR513 shows moderate concerns for carcinogenicity, reproductive, developmental, neurotoxicity along with moderate acute and chronic ecotoxicity. The proprietary aryl phosphates used in the Supresta products display moderate systemic toxicity with one also having moderate genotoxicity and high chronic ecotoxicity. These products should be actually tested to yield empirical evidence of their toxicity characteristics before being considered for use in commerce.

According to this source, the drop-in chemical substitutes for c-pentaBDE in polyurethane foam described in Table 14 either possess persistence and bioaccumulation properties or display ecotoxicity, systemic toxicity, and other characteristics of concern (IPEN, 2007a).

Although c-pentaBDE has been mostly used in PUR foams, it has also been applied as flame retardant in **electric and electronic equipment**. Specifically, it has been used in printed circuit boards in FR2 laminates using phenolic resins (UNEP, 2007k). This type of circuit board has been used in consumer electronic equipment because it is cheaper than the FR4 board which has superior electronic and mechanical properties. Alternatives to c-pentaBDE in this use listed by the Danish Environmental Protection Agency include ammonium polyphosphate, aluminum trihydroxide, and nitrogen and phosphorous compounds or constituents (Danish EPA, 1999, in IPEN, 2007a).

As in the case of HBB, aluminium trihydroxide is also commonly used in electric and electronic equipment. More information on this chemical and how it can be used as BFR alternative can be found in section 5.3.1.

This same report from de Danish EPA also mentions a thermoplastic polymer, polyphenylene sulphide (PPS) as a halogen-free alternative material for this use. PPS is nonflammable, chemically resistant, and contains alternating benzene rings and sulphur atoms. PPS is very brittle and requires fillers to improve strength. In the US, 1,4-dichlorobenzene is used in the synthesis of PPS, which is considered to be cancerinogen (IPEN, 2007a).

Some examples of alternatives to flame retardants currently being utilized by manufactures are: bromine-free circuit boards (Sony); phosphorus-based flame retardants for printed circuit boards (Hitachi); flame resistant plastic (Toshiba); halogen-free materials and low-voltage internal wires (Panasonic/Matsushita) (UNEP, 2007l).

Finally, c-pentaBDE has been used in **textiles** as fire retardant. Bromine free alternatives are available in the market, although some of them, such as antimony trioxide and borax, are not environmentally sound. There are also durable flame retardant materials, such as wool and polyester fibres. However, some manufacturers affirm that a ban on the use of c-pentaBDE in textiles would result in poorer quality and durability of the textile (UNEP, 2007l).

The Danish Environmental Protection Agency describes uses of flame retardants in unsaturated polyester, cotton, and synthetic textiles. Ammonium polyphosphate, aluminum trihydroxide, and reactive phosphorous constituents are listed here as alternatives. In addition, diammonium phosphate (a common component of fertilizers and similar in its features to ammonium polyphosphate) is listed as an alternative for cotton textiles (IPEN, 2007a).

A list of alternative chemicals to c-pentaBDE for use in textiles is provided in Table 16.

Table 16: Bromine-free flame retardant chemicals for textiles

Textile	Alternative flame retardants in commercial materials
PVC, plastic coating of worker clothes	Antimony trioxide
Working clothes, Uniforms for off-shore, electricity plants, military sector, police, health sector	Tetrakishydroxymethyl phosphonium chloride (THPC); Phosphonitrilic chloride (PNC)
Cotton/polyester (bedclothes, clothing, worker clothes, protective clothing) used in public institutions, the off-shore sector, ship and hotels)	Pyrovatex (organic phosphorous compounds)
Cotton/polyester (worker clothes, protective clothing) used in the off-shore sector, ship and hotels	Proban (organic phosphorous compounds)
Carpets, textiles in the transport sector	Aluminium hydroxide
Tent, tarpaulin	Aluminium hydrate
Furniture textiles in the health sector, offices, industry and transport sector	Ammonium compounds; Nitrogen phosphonic acid salt; Zirconium acetate
Furniture for living room and bedroom	Borax; Melamine

Source: UNEP, 2007e.

What it has been stated in section 5.3 on **technical feasibility, efficacy, availability, accessibility** and **costs** of the alternatives to HBB is valid for the alternatives to c-pentaBDE suggested in this section.

In Annex I, an overview of use of alternative flame retardants to c-pentaBDE in several materials and applications is displayed.

5.8 Perfluorooctane sulfonic acid, its salts and Perfluoroctane sulfonyl fluoride

Since the phasing out of PFOS' production by 3M, the World's major producer, in year 2002, industry has progressed in finding alternatives to these substances. This section elaborates on substitutes for those sectors using PFOS-related substances at the present. For those uses described in section 4.7.2 for which alternatives are not

There is evidence that a significant proportion of previous users of PFOS are currently using other fluorochemical products, such as telomers and related products. It should be remarked that although these compounds are not related to PFOS, they may degrade to perfluorooctanoic acid (PFOA) or related perfluorinated carboxylic acids under certain circumstances (UNEP, 2007f).

According to a report from the German Environment Agency published in 2009, the discussion about alternatives to perfluorinated chemicals is difficult, since their qualities are up to now unique, contributing with obvious benefits in multiple applications. Possible alternatives frequently involve a loss in convenience, and in some areas, e.g., in the fighting of fuel-spill fires PFOS-related products are superior to all other extinguishants. Therefore, the economic and social benefits of usage have to be weighed against the dangers, and this is a difficult process (UBA, 2009).

The general rule is that the longer the carbon chain the greater the bioaccumulation probability, so fluorine chemical companies are increasingly turning to short-chain fluorinated compounds with 4 to 6 carbon atoms, for which absorption by human and animals is apparently negligible. Short-chain compounds are also less toxic, but nevertheless persistent, which means that such compounds cannot be degraded. Furthermore, short-chain compounds are better water-soluble, bind less well with surfaces – for example, with sediment and soil particles – and thus have an increased infiltration potential. Current data allow only a provisional estimate of the effects of these short-chain chemicals on man and the environment, so they should not be considered as an environment-compatible substitute (UBA, 2009).

The availability of substitutes can be classified according to the uses where a feasible alternative is not available, and those uses on which PFOS could be substituted without detriment to the quality of products.

5.8.1 Uses without a feasible alternative

According to the photographic industry, alternatives to PFOS-related substances in **photo imaging** are not currently available for all uses. Successful alternatives used by this sector include non-perfluorinated chemicals, chemicals with short (C_3-C_4) perfluorinated chains, telomers, and in a few cases reformulations. The use of these alternatives led to a 60% reduction in the use of PFOS substances worldwide by the photo imaging industry by 2004 (I3A *et al.*, 2007). However, for the following concrete products or applications, there are no currently identified substitutes to PFOS: surfactants in film coatings, electrostatic charge control agents, friction control and dirt repellent agents for film coatings, and adhesion control agents for film coatings. The cost, so far, for replacement of PFOS materials is estimated to be in the range of 20-40 million € for the full range of imaging products, based on the current reduction achievement of 83%. Costs for substituting the remaining 17% is estimated to be twice as much that amount (UNEP, 2007f). It should be remarked that with the introduction of digital technology, there has been a significant decline in the market for photography products (IPEN, 2007d) so the overall amount of PFOS-related substances for this use is expected to decline.

The **photoresist** and **semi-conductor** industry reports some uses where PFOS cannot be replaced by other substances obtaining similar performance. These applications are critical for photolithography applications in manufacturing semiconductor chips: (1) photoresists (as photo-acid generators and/or surfactants); and (2) anti-reflective coatings (as uniquely performing surfactants) (SIA *et al*., 2007). Furthermore, the nature of semiconductor production is such that if alternatives to PFOS are eventually identified at the fundamental research stage, critical adjustment to the chemistry of inputs such as PFOS use in the photolithography process will trigger far-reaching adjustments throughout the manufacturing process and supply chain to ensure that the chemical processes throughout the production process remain aligned. Thus, the semiconductor industry believes it could take an additional ten years to design, operationalize and integrate the new technology, once it has been identified, into the semiconductor manufacturing process (UNEP, 2007f). Costs of substitution, whenever alternatives are available, are expected to be very high, since many resists companies have specific processes, and a valid replacement for one manufacturing facility cannot necessarily be applied industry-wide (SIA *et al*., 2007).

In the production of semiconductors and LCD monitors, **photomasks** are an essential part of the photolithography process. Photomasks are optically transparent fused quartz blanks imprinted with a pattern defined with chrome metal and are the templates used to scribe the circuit pattern into the photoresist. Photomask production is mainly made through a process where PFOS-related substances are contained in etchants for the rendering process. Non-fluoro surfactants are not stable in etchants due to their acid properties, thus they are not applicable for this process. In addition, short-chain PFOS are not suitable because their ability to lower surface tension is not sufficient (UNEP, 2007f).

According to one of the major producers of **aviation hydraulic fluids**, there are no alternatives available for the substitution of PFOS in this application. Furthermore, if a proper substitute was found, the process of qualifying a new fluid for use in commercial aircrafts has historically taken about 10 years from concept to actual commercial manufacture, so PFOS are expected to be needed for this use in the near future.

In addition to the above stated, PFOS have been used also for **certain medical devices** and in **nano-material processing**, both without feasible alternatives at present.

5.8.2 Uses for which alternatives are available

First of all, it should be remarked that the availability of the alternative substances or products displayed below does not necessarily mean that they are in use, since they might need to be phased in.

Within the **metal plating** industry, PFOS-related substances are used in the decorative chromium plating and hard chromium plating, among other applications. Information provided by industry and regulatory authorities indicates that the substitution of Cr (VI) or hexavalent chromium with the less hazardous Cr (III) in decorative plating applications would eliminate the need for the use of PFOS-related substances in this application. Although Cr (III) has higher costs, the difference is more than offset by the savings from reduced waste treatment, air monitoring and record keeping costs. This substitution entails also a reduction in reject rate and a huge reduction in health risks for workers. This option is not viable for hard chromium plating, according to industry and currently there is no technology available on commercial scale to replace Cr (VI) on the majority of plating applications. As substitution of PFOS-based mist suppressants, perfluorobutane sulfonate (C4 PFAS) could be used, or as a technical alternative, improvements on the ventilation systems with extraction. Several studies have calculated the cost of the substitution for groups of manufacturing facilities, or for the related industry in a country or region. A comprehensive figure is provided in a study made in Canada in 2006, with a cost of US$46 per kilogram of PFOS reduced (UNEP, 2007f). Other chemical substitutes such as the nickel- tungsten-silicon carbide composites are in the research phase, and other substitutes such as electroless nickel coating can be used in specific applications (IPEN, 2007d).

There are a number of alternatives available or under development to the use of PFOS-based fluorosurfactants in **fire fighting foams**, such as silicone based surfactants, hydrocarbon based surfactants, fluorine-free fire fighting foams which us synthetic detergent foams (e.g. *Trainol* or *Hi Combat A*^{TM} from AngusFire), protein foams (e.g. *Sthamex F-15* mainly used for training, but also with some marine uses) and other fluorine free-foams, other developing fire fighting foam technologies that avoid use of fluorine, and non-PFOS based fluorosurfactants (like C_6-fluorotelomers, e.g. perfluorohexane ethyl sulfonyl betaine, often used in combination with hydrocarbons e.g. *FORAFAC*^{TM} from DuPont or Dodecafluoro-2-methylpentan-3-one from 3M (UNEP, 2007f, POPRC, 2009). The fluorine-free alternatives have been reported to be approximately 5-10% more expensive than the fluorosurfactant based foams, but the price would fall, if the market size increased. A more deliberate shift towards fluorine-free fire-fighting foam alternatives will probably eliminate the difference in cost (POPRC, 2009).

PFOS is widely used in the production of **electric and electronic parts**. Major uses are as sealing agents and adhesives, for which alternatives are available or under development and PFOS will be replaced relatively quickly. Other uses include belts and rollers in printers and copying machines, also with alternatives available on the market. The only use in electric and electronic parts without substitute is in the intermediate transfer belt and rollers of colour copiers and printers (UNEP, 2007f, POPRC, 2009). It is not clear what the impact of using alternatives to PFOS would be with regards to product performance (UNEP, 2007f). According to information from Japan PFOS is also used in an etching process of the piezoelectric ceramic filter which is used as a bandpass filter at intermediate frequency in two-way radios for police radio, FM radios, TV, Remote Keyless Entry for Cars, etc. Use of surfactant containing PFOS is currently necessary, but alternate technology is being developed and is estimated to be completed by November, 2014 (UNEP, 2008d).

Regarding the use of PFOS derivates as **pesticide** for control of leaf-cutting ants, several mechanical, cultural, biological and chemical methods, including different formulations, have been studied. Granulated baits represent the most widely used method for leaf-cutting ant control, consisting of a mixture of an attractant (usually orange pulp and vegetable oil) and an active ingredient (insecticide), presented in the form of pellets. This method has low cost and delivers high efficiency. Currently, the active ingredients used in ant baits are: sulfluramid, fipronil and chlorpyrifos. Fipronil and chlorpyrifos are more acutely toxic to mammals, water organisms, fish and bees than sulfluramid. Comparative studies demonstrate low efficiency of ant baits with chlorpyrifos and fipronil. It is not quite clear, what alternative pesticides are used in countries, where PFOS is banned. Ant baits with S-Methoprene and Pyriproxyfen are registered in New Zealand to control exotic ants. These pesticides are not killing adult ants but inhibit growth and make them unable to reproduce. Exotic and leaf-cutting ants are different, thus it is not clear, if these or other insect growth regulators are effective against both pests. Synthetic piperonyl compounds seem to kill most of the exposed leaf-cutting ants and may be an alternative. A combination of these two agents could be even more efficient, so there are possible alternatives in the market but they have to be developed and studied (UNEP, 2007f, POPRC, 2009).

For the **impregnation of textiles, leather and carpets**, a mixture of silicones and stearamidomethyl-pyridine-chloride can be used alone as an alternative to PFOS-related compounds or together with a combination of carbamide (urea) and melamin resin. Other alternatives are perfluorobutane sulfonate based substances (PFBS), telomer-based polymers, silicone-based products, PTFE (polytetrafluoroethylene) and highly fluorinated compounds (IPEN, 2007Dd).

Finally, for use in **floor cleaners, polishes or waxes**, the alternatives include acrylates, different C4-perfluorinated compounds (e.g. methyl nonafluorobutyl ether and methyl nonafluoroisobutyl ether), fluorinated polyethers and telomer-based surfactants and polymers (IPEN, 2007d).

Table 17 below summarizes the main use areas of PFOS, information on their use, and the available alternatives.

Table 17. Alternatives to PFOS by use

Use area	Use of PFOS-related substances	Used alternatives
Impregnation of textiles, leather and carpets	PFOS-related substances have been phased out in most OECD countries.	Other fluorinated compounds, like C6-fluorotelomers and PFBS, silicone based products, stearamidomethyl pyridine chloride
Impregnation of paper and cardboard	PFOS-related substances have been phased out in most OECD countries.	Fluorotelomer-based substances and phosphates, mechanical processes.
Cleaning agents, waxes/polishes for cars and floors	PFOS-related substances have been phased out in most OECD countries.	Fluorotelomer-based substances, fluorinated polyethers, C_4-perfluorinated compounds.
Surface coating, paint and varnish	PFOS-related substances have been phased out in most OECD countries.	Telomer-based compounds, fluorinated polyethers, PFBS, propylated aromatics, silicone surfactants, sulfosuccinates, polypropylene glycol ethers.
Oil production and mining	PFOS derivatives may occasionally be used as surfactants in the oil and mining industry	PFBS, telomer-based fluorosurfactants, perfluoroalkyl-substituted amines, acids, amino acids and thioether acids.
Photographic industry	A shift to digital techniques has reduced the use drastically.	Telomer-based surfactants products, hydrocarbon surfactants, silicone products, C_3-C_4-fluorinated chemicals.
Electric and electronic parts	PFOS based chemicals are or have been used in the fabrication of digital cameras,	For most of these uses, alternatives are available or are under development.

Use area	Use of PFOS-related substances	Used alternatives
	cell phones, printers, scanners, satellite communications, and radar systems etc.	
Semiconductor industry	PFOS still used but in lower concentrations	No substitutes with same fitness for use identified. May take up to 5 years according to industry. Should be possible to use PFBS, fluorinated polyethers or telomers.
Aviation hydraulic oils	PFOS-related compounds may still be used.	Other fluorinated substances and phosphate compounds could be used.
Pesticides	Sulfluramid used in some countries as active substance and surfactant in pesticide products for termites, cockroaches and other insects. Other fluorosurfactants may be used as “inert” surfactant in other pesticide products.	Synthetic piperonyl compounds, S-Methoprene, Pyriproxyfen, Fipronil, and Chlorpyrifos are alternative active substances, eventually in combination. Alternative surfactants may be possible to identify.
Medical devices	Old video endoscopes at hospitals contain a CCD colour filter that contains a small amount of PFOS. PFOS is also used as an effective dispersant, for contrast agents in radio-opaque catheters.	Repairing such video endoscopes requires a CCD colour filter containing PFOS. New CCD filters are PFOS-free. For radio-opaque ETFE perfluorobutane sulfonate (PFBS) can substitute PFOS.
Metal plating	PFOS-compounds are still used in hard chrome plating. Cr-III has replaced Cr-VI in decorative chrome plating.	Some non-fluorinated alternatives marketed but not considered the same fitness for use in hard chrome plating. A C_6-fluortelomer is used as substitute and may be efficient. May be also PFBS derivatives. Physical barriers may also apply.
Fire-fighting foams	PFOS-related substances have been phased out in most OECD countries in new products. Stocks are still used up.	C_6 – fluorotelomers are used as substitute in new products; fluorine-free alternatives used for training exercises and may be other places than offshore.

Source: POPRC, 2009.

6. Waste management

6.1 General information on POPs waste management

The new POPs listed to the annexes of the Stockholm Convention were used or have been in use for several years. Therefore, even once the use of these substances is banned or severely restricted, an important issue to tackle is the management of the stockpiles in the warehouses of the production facilities, or the final disposal of those articles containing these substances that have been put in the market at the end of their lifespan.

The issue of waste management is considered in Article 6 of the Stockholm Convention. According to this article, each Party shall develop appropriate strategies for identifying stockpiles consisting on or contaminated with chemicals listed in Annexes A or B, and for identifying products and articles in use and wastes consisting of, containing or contaminated with a chemical listed in Annex A, B or C, and put those strategies in place so the actual identification occurs to the extent practicable. In addition, each Party shall manage stockpiles and wastes in a safe, efficient and environmentally sound manner, and take appropriate measures to ensure that POP wastes are handled, collected, transported, and stored in an environmentally sound manner. Those wastes should be disposed of in such a way that the POP content is destroyed or irreversibly transformed so that does not exhibit the characteristics of persistent organic pollutants.

Environmentally sound management (ESM) is a broad policy concept without a clear universal definition, but there are some provisions as it applies to waste consisting of, containing or contaminated with POPs within the Basel Convention, the Stockholm Convention and the Organisation for Economic Co-operation and Development (OECD), that can be used as general international guidelines of procedure.

The **Basel Convention** defines ESM of hazardous wastes and other wastes in its Article 2, paragraph 8, as “taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against adverse effects which may result from such wastes”. It also establishes some criteria regarding the waste management regulatory framework, facilities, operators, monitoring and personnel involved.

The **Stockholm Convention** does not define the term environmentally sound management, but establishes cooperation mechanisms with the appropriate bodies of the Basel Convention.

The **OECD** has adopted a recommendation on ESM of wastes which includes various items, inter alia core performance elements of ESM guidelines applying to waste recovery facilities, including elements of performance that precede collection, transport, treatment and storage and also elements subsequent to storage, transport, treatment and disposal of pertinent residues. Those elements cover aspects as the existence of health and environment management systems, training and monitoring programmes and closure and after-care plans (Basel Convention, 2010).

The general technical guidelines described by the Basel Convention for the ESM of hazardous wastes are listed below (non-intensive list; further information on these techniques can be found in Basel Convention, 2010):

1. Pre-treatment operations: adsorption and absorption, dewatering, mechanical separation, mixing, oil-water separation, pH adjustment, size reduction, solvent washing, thermal desorption.

2. Destruction and irreversible transformation methods: alkali metal reduction, base-catalysed decomposition (BCD), catalytic hydrodechlorination (CHD), cement kiln co-incineration, gas-phase chemical reduction (GPCR), hazardous-waste incineration, photochemical dechlorination (PCD) and catalytic dechlorination (CD) reaction, plasma arc, potassium tert-Butoxide (t-BuOK) method, supercritical water oxidation (SCWO) and subcritical water oxidation, thermal and metallurgical production of metals, waste-to-gas conversion.

3. Other disposal methods when neither destruction nor irreversible transformation is the environmentally preferable option: specially engineered landfill, permanent storage in underground mines and formations,

The following sections describe the waste management strategies and techniques identified in the bibliographic research for each of the new substances listed in the annexes of the Stockholm Convention.

6.2 Hexachlorocyclohexane (alpha, beta and gamma isomers)

These three compounds are treated simultaneously here due to their similar characteristics.

The best waste management strategy available for any substance is to reduce the production of such compound. This was possible in the case of alpha- and beta-HCH, since, as it has already been said, these compounds originate as residuals in the production of gamma-HCH or lindane from technical HCH. To reduce the generation of those isomers, they were transformed into the solvent trichlorophenoxyacetic acid, HCl, hexachlorobenzene, sodium pentachlorophenolate and trichlorophenol. These operations were discontinued in the 1970s or in the 1980s depending on the sources, but several hundred thousands of HCH residuals were used for this purpose (UNEP, 2008a, IPEN, 2007c).

Another reported use for the residual alpha-HCH is for the production of pentachlorophenol (PCP) from hexachlorobenzene, which requires the use of alpha-HCH (UNEP, 2008a).

Management strategies for HCH are in many cases closely related to decontamination of polluted soils techniques, since frequently HCH wastes ended up in soils, due to intentional dumping or accidental releases. Depending on the occurrence of pollution and possible remediation measures the intensity of the contamination is a general dividing line for management strategies. Obsolete stocks and intensively contaminated soils (‘hot spots’) are still a primary source for emissions and therefore would be worth employing ex-situ- and off-site-treatment strategies involving excavation, regionally centralised intermediate storage and treatment plants. Treatment itself can involve thermal and extraction techniques and should be undertaken in a manner consistent with Convention guidelines.

For polluted soils with a low intensity of HCH more extensive strategies for on-site and in-situ-treatment and reduction are probably more appropriate. Degradation processes (mostly anaerobic) taking place in soil have been described for alpha-, and beta-HCH establishing the principles for ex-situ biological treatment techniques (e.g. slurry reactors, landfarming, composting systems). Any of the available extensive bioremediation techniques should be adapted regionally with respect to soil properties as well the available materials for stimulating degradation and should be undertaken in a manner consistent with Basel Convention guidelines referred to in the previous section (UNEP, 2008a).

Disposal techniques with increased efficiency and quality of disposal at a greatly reduced cost have been reported in United States. One example is the use of demulsification, sorption, and filtration in combination with chemical and biological degradation of pesticide waste. This process is divided into two phases, being the first one the use of demulsification agents (lignocellulosic materials, peat moss, wood products, etc.) in the removal of solubilized pesticides. In phase II, the solid matter (pesticide-saturated sorbents and suspended particulates) is physically separated from the aqueous material through a variety of filtration techniques. The aqueous phase is either recycled or discarded, and the solid phase, in which the concentration of the pesticide is most significant, is further treated through composting. Additional work is required but this disposal technique has clear benefits: cost effectiveness, reliability, and adaptability to several pesticides, in addition to lindane (Mullings *et al.*, 1992 in ATSDR, 2005).

From a general perspective, the implementation of new waste management practices usually cause a positive stimulating effect for employment, and hence have overall positive economic effects. This fact should be taken into consideration when developing and implementing waste management strategies, especially in countries with economies in transition, where proper handling of wastes and remediation of contaminated sites should be seen as a niche of economic improvement.

It has already been said in previous sections that the production of one ton of lindane generates up to eight tons of alpha- and beta-HCH isomers. Production of lindane in the past, in connection with inappropriate handling of these HCH residuals as well as existing stockpiles have generated important amounts of waste spread into the environment into developed and developing countries. Thus, major costs related to hexachlorocyclohexane waste management will arise from environmentally sound management of hazardous waste and stockpiles of HCH residuals, as well as from the remediation of contaminated sites (UNEP, 2008a).

Information on costs for the management of HCH wastes are available from several regions in the World, such as the Basque Region (Spain), the Netherlands, Czech Republic and Russian Federation with quantities ranging from 2 to 100 million Euros, depending on the activity carried out. Estimated cost for HCH cleaning up operations in the US has been reported in US$2,000 to 3,000 per ton (UNEP, 2008a), in the same order of magnitude than the cost estimated by IHPA and FAO (IHPA, 2009).

6.3 Chlordecone

Since chlordecone is not flammable and very stable in the environment, many disposal methods investigated for this chemical have proven unsuccessful.

Degradation of chlordecone has been evaluated in the presence of molten sodium. Addition of chlordecone to molten sodium at a temperature of 250 ºC resulted in significant degradation of chlordecone with small quantities of <12 ppm observed in the reaction products.

Microwave plasma has also been investigated as a potential disposal mechanism for chlordecone. An estimated 99% decomposition was observed in a 5-kw microwave plasma system for 80% chlordecone solution, slurry, or solid.

Another recommended disposal method for chlordecone is destruction in an incinerator at approximately 850 ºC followed by off-gas scrubbing to absorb hydrogen chloride.

Activated carbon adsorption has been investigated for the treatment of waste waters contaminated with chlordecone. The discharge of chlordecone in sewage disposal systems is not recommended, as it may destroy the bacteriological system.

Chlordecone as a waste product in water with concentrations in the ppm range and lower may be dehalogenated by a process involving ultraviolet light and hydrogen as a reductant. The reaction is pH dependent, and degradation is best when the system contains 5% sodium hydroxide. Using this method, 95-99% of chlordecone is removed within 90 minutes. The degradation products are the mono-, di-, tri-, tetra-, and pentahydro derivatives of chlordecone (Various authors cited in US ATSDR, 1999).

Regarding soil contamination with chlordecone, common techniques of soil decontamination such as solvent extraction and incineration are cost intensive.

Microbiological degradation is not promising as it shows only low degradation rates and leads to degradation products with similar toxicity to chlordecone itself.

Phyto-remediation has been reported to be a possible economically viable option for the decontamination of soil, since this substance is taken up by specific plants from the soil. However it is noted that according to the current state of knowledge, phyto-remediation requires large time scales (several centuries) to achieve similar decontamination rates as in solvent extraction (UNEP, 2007h).

6.4 Hexabromobiphenyl

HBB has already been largely phased-out, so the appearance of this substance in municipal waste should be minimal. However, there is a possibility that some releases occur from articles with long lifespan from former consumer uses of HBB including ABS plastic used for business machine housings and electrical products such as radio and TV, cable coatings, and polyurethane foam (IPEN, 2007b). Other sources assume that there are hardly any products in service containing HBB because they are virtually all disposed of. Impacts concerning stocks, waste and disposal or contaminated sites are not expected (UNEP, 2007i).

Concerns over export of electronic waste to developing countries leading to HBB releases during recycling operations have been expressed (IPEN, 2007b), and should be taken into consideration by the competent authorities when implementing waste management strategies.

Burning or incineration of HBB-containing waste could lead to formation and release of brominated dibenzo-p-dioxins and -furans (IPEN, 2007b), so appropriate abatement techniques should be used when performing these operations.

It is very likely that the most common waste management option for HBB-containing equipment over the years has been land filling followed in importance by incineration (US ATSDR, 2004).

6.5 Polybrominated Diphenyl Ethers (PBDEs)

Due to similarities in chemical properties and uses, this section compiles information on waste management for the following substances (or products and articles containing them): tetra-BDE, penta-BDE, hexa-BDE, hepta-BDE and octa-BDE.

PBDEs are currently used as flame retardants in a wide range of consumer products (see sections 4.4.2 and 4.8.2).

Waste management operations for article containing these compounds include, according to the retrieved information, disposal in landfills, recycling and incineration with or without energy recovery.

Landfill disposal of **plastic consumables** containing pentaBDE (e.g., polyurethane foams) and octaBDE (e.g., computer monitors) in the United States is likely to increase as reported by the United States due to their limited useful lifespan (US ATSDR, 2004), and a similar pattern could be expected worldwide, unless alternate management strategies are put in place. Given that all PBDEs have low water solubility, the potential for leaching of PBDE from landfills appears to be small, but in any case, well-designed landfills will include measures to minimize leaching and those measures would also be effective in minimizing the leaching of any PBDE particulates present (US ATSDR, 2004).

A study made by the WWF in 1998 estimated that in England, Wales, Germany, **France** and **Spain**, approximately 63% of old personal computers were disposed of to landfills (European Commission, 2003). This fact has changed substantially in the

European countries with the entry into force of specific regulations on waste from electronic equipment[5] establishing targets for recovery and recycling of this type of waste. Current average landfill disposal figure in the EU is estimated in 13%, but special attention should be paid to the 54% reported to have sub-standard treatment inside the EU, or illegally transferred to non-EU countries (European Union, 2008). It should be mentioned that in the EU, since December 2006, plastics containing PBDEs as fire retardant must be separated from electric and electronic appliances prior to recovery and recycling.

While some sources identify **recycling** of plastic materials containing PBDEs is a common practice in industry (US ATSDR, 2004), others mention that major electronic manufacturers are unwilling to accept new equipment made from recycled material such as off-cuts, since the resultant product might have lower quality standards. There was an initial concern on the possibility that recycling operations for plastic containing PBDEs would release dioxins and furans, but the studies carried out showed no increase in the levels of the brominated dibenzofurans and dibenzo-p-dioxins as a result of the recycling process (European Commission, 2003). In this same report published in 2003, it was stated that there was little recycling of plastic containing polybrominated diphenyl ether in the EU, although this was expected to change, since recycling of many plastics was by then at the experimental stage. According to the Bromine Science and Environmental Forum (BSEF), one of the main related industry associations, only in a limited number of cases of plastic recycling operations are economically viable because of the relatively low cost of new, virgin plastics. In any case, experience shows that for material recycling to be viable, there must be homogenous plastics and a large constant waste stream. The markets for recycled plastics are limited due to technical feasibility and economics, and small impurities from different plastics or other materials can easily occur during the recycling processes drastically decreasing the electrical and mechanical performance or safety of recycled plastics.

Regarding **polyurethane foam** containing PBDE, the final mode of disposal is likely to be ultimately landfilling or incineration. Scrap foam can be recycled but these recycled products will also eventually end up being disposed of in a similar manner. The recycling of polyurethane foam is carried out mainly by shredding the scrap foam into small pieces and mixing with an adhesive under pressure to form a large cylinder or block. The foam product is then “peeled” from the block at the desired thickness and a suitable backing is applied. This type of recycling is common in the United States, and

[5] Directives 2002/95/EC and 2002/96/EC.

the EU is a net exporter of scrap foam for this process. Other uses for scrap foam such as regrinding and subsequent use as filler in a variety of applications have been reported. As these recycling processes are generally physical in nature and do not involve the temperatures associated with some plastic recycling processes, the potential for formation of brominated dibenzofurans and dibenzo-p-dioxins from recycling polyurethane foam containing pentabromodiphenyl ether is likely to be low (European Commission, 2003).

Incineration of waste materials containing PBDEs is thought to be a potential source of PBDFs and/or PBDDs, although with modern plants and operations maintained at sufficiently high temperatures and with long residence times, this problem is substantially reduced (US ATSDR, 2004; European Commission, 2003).

Regardless the waste management strategy followed a special challenge could be to separate PBDE containing articles from those without these substances, since most articles are not labelled according this aspect. National authorities would have to conduct surveys to get more detailed information about PBDE content in different articles becoming waste. Technically, the challenge would be the separation of bromine-containing and non-bromine-containing plastic components. Technologies on this field are emerging, thus aiding waste management and possible recycling, but they are expensive.

To ensure proper handling of PBDE-containing waste material/articles in developing countries is expected to be complicated, since these countries have limited experience in handling this kind of waste, so they would need practical help and information as well as financial support to ensure environmentally sound handling of this waste. The assistance could include how to dismantle PBDE-containing articles, treat the various parts and the methods of environmentally sound treatment of the final PBDE (UNEP, 2008e).

6.6 Pentachlorobenzene

Information on PeCB waste management options is limited, mainly because the available information leads to believe that the existence of the product itself as a separate substance is unlikely. It could be present as traces in several pesticides and fungicides, and as a component in PCB, already included in Annex A of the Stockholm Convention and with clear waste management strategies set by guidelines of the Basel Convention.

In any case, an appropriate technique for the management of substances containing PeCB seems to be the incineration with proper conditions of temperature, turbulence, residence time and dedicated abatement techniques. It is indicated that incinerators complying with EU legal requirements of the limit value for PCDD/F of 0.1 ng/m3, will undoubtedly minimize the releases of PeCB (UNEP, 2008c).

6.7 Perfluorooctane sulfonic acid, its salts and Perfluorooctane sulfonyl fluoride

Waste streams from the use of PFOS-related substances in the photographic, semiconductor and aviation sectors should be disposed of using high temperature incineration according the requirements of the EU Directive on waste incineration or any other regulation establishing similar emission levels and operation conditions (RPA, 2004).

However, the semi-conductor industry associations have expressed their concerns on the incineration of contaminated aqueous waste originating from developer processes, which would represent a new and significant cost. Semi-conductor industry data indicates that, in developer applications, PFOS is present at around 0.01% and 195 kg/year are used in the EU (available data). The cost of incinerate all the aqueous waste generated by the industry and contaminated with PFOS, would be nearly €4 million per year only across the EU (RPA, 2004).

On this basis, 1,950t of developer are used in the EU in the semiconductor industry. Industry has claimed that 12,000t of aqueous waste is generated every year by the process, implying that all of this would be contaminated with PFOS and would require treatment. However, this implies a dilution factor of developer wastes of around six times. This would seem reasonable only if developer waste effluents were mixed with other aqueous wastes from other processes. As such, it has been assumed that developer wastes could be segregated from other aqueous waste streams and would be diluted by a only factor of two. It is suggested, therefore, that 3,900 t of PFOS contaminated aqueous waste would be generated per year in the EU. Assuming €1000/t (£600/t) for high temperature incineration, this equates to a cost of €3.9 million (£2.3 million) per year across the EU (RPA, 2004). In addition, the final semiconductor product does not carry any traces of PFOS-related substances. The solvent waste attributable to critical photolithography applications, which accounts with 82% of the PFOS used by the semiconductor industry in critical applications is incinerated with a destruction efficiency of >99.99% (SIA *et al.*, 2007).

An alternative waste management strategy to incineration, final disposal in authorized hazardous waste landfills has been identified to occur, for instance, in Canada.

7. The new POPs in the Mediterranean Region

Although there is more information for some substances than for others, a representative statement could be that actual data on the new POPs regarding the countries party to the Mediterranean Action Plan is scarce and very scattered through several studies and reports.

In an attempt to gather first-hand information from the countries under study, several questionnaires were prepared and sent to various contacts and experts on the subject from each country. An exhaustive follow up has been made both by mail and by phone, but the responses obtained have not been as satisfactory as expected. **Only thirteen of the 22 MAP parties** have fulfilled and submitted the questionnaire or provided information on where to find relevant data, and none of the almost **60 international experts** consulted by mail have sent information (although some non-governmental organizations did send some other local contacts).

A difference in management strategies and progresses made can be established among the MAP developed countries, where more assets have been put into the fulfilling of the Stockholm Convention’s requirements, and those considered as developing countries or countries with economies in transition. These countries face several problems in adapting their legal framework to comply with international agreements, such as the Stockholm Convention, or even to develop adequate monitoring programmes to be able to understand the real situation of use and management of the new chemicals regulated by the Convention.

In order to effectively control POPs, a series of events and establishment of infrastructure are necessary. These include monitoring the chemicals, public awareness programmes, actions by the government, reactions of industry, technical remediation and preventive measures. The various players likely to be involved have many handicaps in developing countries, according to UNIDO, 2010:

- Government: lack of environmental laws or regulations, lack of detailed implementation scheme for chemical management, limited capability to evaluate diverse chemicals and technology to meet country's needs, lack of preventive or emergency procedures for chemicals, not able to adopt risk assessment and management which might disclose decision making and transparency, accidents not investigated in technical terms and no lessons learned to prevent future accidents, lack of manpower or equipment to monitor and remediate polluted sites, lack of mechanisms to evaluate chemicals imported into the country, lack of a proper documentation system for pollutants released and transferred within the country.

- Industry: lack of capability to cope with general environmental problems, limited in man-power and equipment to monitor and manage pollutants, lack of sense of 'responsible care' or life-cycle management of the products.

- Public: no substantive experience with chemical hazards, limited information on long-term hazards of chemicals, lack of safety procedures knowledge in dealing with chemicals, hypersensitive reaction to reports of presence of toxic substances in food or water.

- Coordination among sectors: no consensus on risk management among sectors, limited coordination among ministries and agencies, and even departments, limited coordination among different academic disciplines concerned with chemical safety.

This section compiles the information found from several sources and documents in a comprehensive manner, grouping it into sub-sections tackling the most important issues regarding the new POPs in the Mediterranean. A general outlook in the Mediterranean countries will be given here, including in some cases tables clarifying the situation in several countries regarding a concrete issue, or important aspects discovered through the bibliographic research or provided in the questionnaires' responses.

However, accurate available information for each country is displayed in the country profile tables, in section 8. It should be underlined that some data might be repeated in both this section and section 8, but it was considered important for the better comprehension of the Mediterranean framework to have both approaches: regional and national.

7.1 Legal and management framework

MAP countries Member States of the European Union have a clear legislative framework regarding all the new POPs listed to the Stockholm Convention. **Regulation EC 850/2004**, in its Article 3, bans the production, placing on the market and use of substances listed in Annex I of the Regulation, which includes **chlordecone, hexabromobiphenyl** and **hexachlorocyclohexane** (α-HCH, β-HCH, lindane), with the following exemptions: (1) substances used for laboratory-scale research or as a reference standard; (2)substances occurring as an unintentional trace contaminant in substances, preparations or articles; (3) substances occurring as a constituent of articles produced before or on the date of entry into force of the Regulation until six months after the date of its entry into force; (4) substances occurring as a constituent of articles already in use before or on the date of entry into force of the Regulation. This Regulation has been recently amended by Regulations (EU) 756/2010 and 757/2010 for the inclusion of all the new POPs, prohibiting their use in Europe with some specific exemptions for some uses or in certain concentrations.

In addition, **Council Directive 75/769/EEC** and its modifications restricts the marketing and use in the Member States of the Community of the dangerous substances and preparations listed in its Annex. These include:

- **Polybromobiphenyls** (which includes HBB): may not be used in textile articles, such as garments, undergarments and linen, intended to come into contact with the skin.

- **Penta-BDE** and **Octa-BDE**: may not be placed on the market, used as a substance or as a constituent of substances or of preparations in concentrations higher than 0.1 % by mass.

- **PFOS**: (1) May not be placed on the market or used as a substance or constituent of preparations in a concentration equal to or higher than 0,005 % by mass; (2) May not be placed on the market in semi-finished products or articles, or parts thereof, if the concentration of PFOS is equal to or higher than 0,1 % by mass calculated with reference to the mass of structurally or microstructurally distinct parts that contain PFOS or, for textiles or other coated materials, if the amount of PFOS is equal to or higher than 1 μg/m2 of the coated material. Particular exemptions are established for some uses.

Finally, **pentachlorobenzene** is identified as priority hazardous substance in the **Directive 200/60/EC** of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy. These substances will be subject to cessation or phasing out of discharges, emissions and losses within an appropriate timetable that shall not exceed 20 years.

The situation for non-EU Member States is less clear, but available information on a country basis by substance is provided in the country profiles (section 8).

For the concrete case of **lindane**, information on the registration status by country is provided in

Table **18**.

Table 18: Legal status of lindane in some MAP countries.

Country	Legal status
Algeria	Restricted / Severely restricted
Croatia	Banned
Cyprus	Banned since 1987
Egypt	Banned
France	Banned since 1998[6]
Italy	Restricted / Severely restricted
Monaco	Not registered
Morocco	Restricted / Severely restricted
Slovenia	Not registered
Spain	Restricted / Severely restricted
Syria	Registered
Turkey	Banned

Source: USEPA, 2006; IHPA, 2006.

According to Regulation (EC) 850/2004, the use of lindane in Europe is banned for all uses since 31 December 2007, expiration date of the exemptions for use that where set in its Annex I.

7.2 Production, uses, import, export and trade

It is difficult to establish a general outline on the production, uses, import, export and trade of the new POPs listed to the Stockholm Convention, since the situation varies among countries and among compounds. Table 19 compiles the information provided by the International POPs Elimination Network. For countries not mentioned in the table, either the information is not available, or they do not produce any of the new POPs. In any case, information by country and substance is provided later in the country profiles.

Table 19: Producers of the New POPs in the Mediterranean region.

Substances	MAP Countries / Companies	Commercial nouns
alpha-Hexachlorocyclohexane (α-HCH)	No intentional production.	*N/A*
beta-Hexachlorocyclohexane (β-HCH)	No intentional production.	*N/A*
Chlordecone	France / De Laguarique	Kepone®, GC-1189, Merex, ENT 16391, Curlone
Hexabromobiphenyl (HBB)	France / Atochem	FireMaster®
Commercial Pentabromodiphenylether (pentaBDE)	Israel / Dead Sea Bromine Group No intentional production[7]	*N/A*
Commercial Octabromodiphenylether (octaBDE)	France Israel	*N/A*
Lindane (γ-HCH)	Albania France Italy Turkey[8]	*N/A*
Pentachlorobenzene (PeCB)	No intentional production	
Perfluorooctane sulfonic acid (PFOS) and its salts	Italy / Miteni S.p.A / EniChem Synthesis S.p.A	*N/A*
Perfluoroctane sulfonyl fluoride (PFOS-F)	No intentional production.	*N/A*

Sources: Compiled from several documents in the IPEN website (data from 2008 and before); OECD, 2002 (producers in Italy). N/A: not available

However, the above presented data is from year 2008 and before. The production of the New POPs in the EU Member States is banned (with some specific exemptions) in the publication date of this study.

[6] According to IHPA, 2006. In USEPA, 2006 appeared as Restricted / Severely restricted.

[7] Currently, it is believed that this substance comes primarily from unintentional production from sources including: PCBs, chlorinated solvents, pesticides, chemical manufacturing, aluminium smelting, burning of wastes including packaging, processing of minerals for the production of metals as magnesium, copper, niobium, tantalum, titanium dioxides, wood treatment plants and incineration of hazardous substances.

[8] Currently, It seems that this substance it is not produced in this country.

Regarding the uses given to the new POPs in the Mediterranean region, specific information has not been found. However, it can be assumed that the most frequent uses are common regardless the geographical area. Table **20** compiles the known uses given to the substances under study in the past and those that are more likely to occur in the countries not having phased out these compounds. For further information, please refer to section 4.

Table 20. Past and current uses of the New POPs

Substances	Past and current uses
alpha-Hexachlorocyclohexane (α-HCH)	None, it is an unintentional derivate for discarding. It was a by-product of the production of the insecticide lindane.
beta-Hexachlorocyclohexane (β-HCH)	None, it is an unintentional derivate for discarding. It was a by-product of the production of the insecticide lindane.
Chlordecone	Pesticide previously used to treat root disease of banana, mildew, potato moth, rust, other insects, and in traps.
Hexabromobiphenyl (HBB)	It has been used as a flame retardant in thermoplastic acrinotril-butadiene-styrene (ABS) for the construction, electric appliance and electrical products industry as well as in polyurethane foam for auto upholstery.
Commercial Pentabromodiphenylether (pentaBDE)	It is used almost exclusively for the manufacture of flexible polyurethane (PUR) foam for furniture and upholstery in homes and vehicles, packaging and PUR without foam for electronic equipment. It is also sometimes used in specialized applications in textiles and industry.
Commercial Octabromodiphenylether (octaBDE)	It is used as flame retardant primarily for ABS plastic used in offices equipment and commercial equipment. Other uses include nylon, low density polyethylene, polycarbonate, phenol-formaldehyde resins and unsaturated polyesters.
Lindane (γ-HCH)	It has been used as high-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and also as antiparasitic applications to humans and animals.
Pentachlorobenzene (PeCB)	There are currently no intentional uses, although it has been discovered in the following uses: PCBs, packages of dyes, flame retardants and pesticides (quintozene, endosulfan, chlorpyrifos methyl, atrazine and clopirilida). It was also used as an intermediate in the manufacture of the fungicide pentachloronitrobenzene.

Substances	Past and current uses
Perfluorooctane sulfonic acid (PFOS) and its salts	It is used for: foam fire, carpets, leather linings, textiles and fillers, paper and packaging, fillers and additives of fillers, industrial and domestic cleaners, pesticides and other insecticides, photographic industry, photolithography and semiconductor manufacturing, hydraulic liquids, and silvered of metal.
Perfluorooctane sulfonyl fluoride (PFOS-F)	It is used to make perfluorooctane sulfonic acid (PFOS) and PFOS-based compounds.

Source: personal compilation from several sources, mainly from IPEN.

For the particular case of **pentachlorobenzene**, although the substance itself has been reported not to be longer used in the production of quintozene, it was used in the past. Thus, the quintozene currently used in some countries could lead to the release of PeCB from the traces that might contain. Table 21 displays the information gathered on the production of quintozene in some of the Mediterranean countries.

Table 21: Production and use of quintozene in some MAP countries.

Country	Production of quintozene	Use of quintozene	Releases of quintozene or PeCB
Albania	No information	No commercial use	No information
Croatia	No information	No use of quintozene in the last 10 years	Detected in human milk in 1979 and 1980
France	N/A	Use of quintozene	N/A
Greece	N/A	Use of quintozene	N/A

Source: Van de Plassche, E. et al., 2002.

Regarding the **chlordecone**, available information suggests that it was used in the territory of **France** from 1981 to 1993, produced by De Laguarique. However, reported usage occurred in Martinique and Guadeloupe (UNEP, 2007g), both overseas regions of France located in the Caribbean Sea, so the possible pollution originated from the use in these regions would not affect the Mediterranean region.

With regard to **lindane**, according to ATSDR, 2005, this compound was not produced in the United States, but it was imported from **France** and **Spain** (where the production has stopped, according to the NIP), among other countries. In **Morocco** lindane was used in the past but has been banned for use since 1995. However, there are in the country large stockpiles that have possible environmental impacts (UNEP, 2008a; UNEP, 2007c). Finally, **Albania**, **Croatia**, and **Turkey** are reported to have produced lindane in the past, but evidences indicate that the production has stopped.

7.3 Main emissions sources and exposure routes

It is expected that in the Mediterranean region sources and exposure routes of the new POPs listed to the Stockholm Convention are alike to the ones occurring in other regions. Information on this subject has already been provided in the sub-sections “Releases to the environment” of section 4 for each substance (or group of substances). Nevertheless, Table 22 compiles the most important aspects regarding sources of these compounds to the environment.

Table 22. Main releases of POPs into the environment

Substances	Main sources
alpha-Hexachlorocyclohexane (α-HCH)	Historically, the main pathway has been emissions from technical-HCH and lindane manufacturing facilities. Releases from hazardous wastes stockpiles of lindane are also possible.
beta-Hexachlorocyclohexane (β-HCH)	Historically, the main pathway has been emissions from technical-HCH and lindane manufacturing facilities. Releases from hazardous wastes stockpiles of lindane are also possible.
Chlordecone	The main source into the environment has been through the direct application to crops as a pesticide, and the consequent surface runoff and percolation to groundwater.
Hexabromobiphenyl (HBB)	The most common pathways were to air during production, solid losses to landfill from drying, handling, shipping and transportation, to soil in bagging and loading areas, and to waste water from the quenching and washing of the PBBs as they were recovered from the reaction mass. They can also arise from the widespread use as flame retardant.
Commercial Pentabromodiphenylether (pentaBDE)	Releases to the environment might occur in the production process and subsequent handling, or during the whole life-cycle of the product where was used as flame retardant.
Commercial Octabromodiphenylether (octaBDE)	Releases to the environment might occur in the production process and subsequent handling, or during the whole life-cycle of the product where was used as flame retardant.
Lindane (γ-HCH)	Most current releases of lindane are related to its formulation and its use as a pesticide. Historically, the largest source of lindane releases to the air resulted from its agricultural application; other air releases occurred during the manufacture of the pesticide. Lindane can be released to surface water via surface runoff (as the dissolved chemical or adsorbed to particulates) or via wet deposition. It can be released to the soil by direct application of the pesticide to soil or by direct or indirect releases during formulation, storage, and/or disposal. Hazardous waste sites where γ-HCH has been disposed of in the past are sources of γ-HCH in soils.

Substances	Main sources
Pentachlorobenzene (PeCB)	At present, a majority of the PeCB released into the environment is a result of combustion processes: biomass combustion, combustion of solid waste and combustion of coal. Industrial sources (chemical manufacturing, waste disposal, aluminium casting, PCB use losses) are relatively minor and improvements in industrial practices have probably led to the reductions in environmental concentrations of PeCB. Also, PeCB can be result from degradation of other chemicals in the environment.
Perfluorooctane sulfonic acid (PFOS) and its salts, and Perfluoroctane sulfonyl fluoride (PFOS-F)	There is very limited information regarding the emissions and pathways of PFOS to the environment. Although manufacturing processes are considered to be the major source, releases are likely to occur during their whole life cycle to atmosphere, soil and superficial and groundwater.

Source: personal compilation from several sources.

7.4 Stockpiles

Information on stockpiles at the regional level has not been found. The available data on a country basis is provided in the country profile tables, but some aggregated data regarding lindane has been provided by IHPA, and is showed in Table 23 below.

Table 23: Stockpiles of lindane in some MAP countries.

Country	HCH amounts in tonnes
France	330,000
Italy	unknown
Turkey	3,000[9]

Source: IHPA, 2010; Information provided through questionnaire.

7.5 Viability of substitution

Information on the viability of substitution is provided in section 5 for each substance. What is stated there on a general basis should be valid for the Mediterranean region.

There are some substitutes that require certain investment for the companies to be implemented or higher production costs. In these cases, developing countries or countries with economies in transition may have more difficulties to achieve the desired

[9] Data provided by the Ministry of Environment and Forestry through the questionnaire sent as part of this study, but IHPA, 2010 estimates that in Turkey there are 23,000 tonnes of HCH as stockpile (data updated in February 2010).

level of substitution, and might require some international financial support or technical assistance.

In those countries, substitution might be hindered by the lack of a legal framework, political will or lack of technical knowledge or capacity. In some cases, the obstacle lays in earlier stages of the substitution process, since there is no knowledge of the usage of the new POPs in the country, and monitoring programmes to evaluate the existence of stockpiles have not been put in place.

For the European Union Member States MAP countries, substitution for those chemicals and uses where is possible has already taken place, or is under development, since the appropriate legal framework with clear deadlines for limiting the use or phasing out those substances already exist.

7.6 Information, awareness and education

Actual information on this subject has not been found either through the bibliographic research or through the questionnaires. However, in most cases, the development of programmes to inform, educate and raise awareness among the general population and affected industries is a secondary step after the development of a legal framework and monitoring programmes. Hence, it is expected that in those countries with those mechanisms in place the occurrence of such programmes is higher than in countries lacking the mentioned mechanisms.

8. Country profile

This section presents several tables compiled form the information sent by the contacted national authorities in each country, and in some cases completed with data from the bibliographic research.

The country profile has only been made for those countries who submitted the questionnaires, since for the rest of the countries, available information was not enough to complete all the necessary information for a country profile.

However, specific data for some of the MAP countries was found during the documentation research, and is presented below:

- **Lebanon:** reported no production or use of HBB.
- **Italy:** Official data of releases to the environment in Italy is available for some years, according to the Pollutant Releases Transfer Registry, as displayed in Table 24.

Table 24: Releases to the environment of the new POPs in Italy according to PRTR.

Chemical	Year	Quantities	Unit
Lindane	2007	11.5	Kg
	2008	92.7	Kg
HCH	2003	9.8	Kg
	2004	1.5	Kg
	2005	39.1	Kg
PeCB	2002	12.9	Kg
	2003	48	Kg
	2004	49.9	Kg
	2005	37.8	Kg
HBB	2008	55.2	Kg

Source: personal compilation from the public information available in the Italian and European PRTR websites.

- **France:** Official data of releases to the environment in France is available for some years, according to the Pollutant Releases Transfer Registry, as displayed in Table 25.

Table 25: Releases to the environment of the new POPs in France according to PRTR.

Chemical	Year	Quantities	Unit
Lindane	2008	3.23	Kg
HCH	2004	86	Kg
	2005	59	Kg
	2006	66	Kg
	2007	196	Kg
	2008	823	Kg
PeCB	2007	0.0042	Kg

Source: personal compilation from the public information available in the French and European PRTR websites.

Finally, it should be remarked that despite the fact that many EU MAP Countries could not fulfil the questionnaire, the information provided by France regarding their legal and management strategies could be extrapolated to other EU MAP members.

Remarks for the country profile tables:

N/A: not available or unknown

Level of substitution: (0) No available substitutes in the market; (1) Substitutes available in market but minimally used; (2) Substitutes available in market and commonly used.

References: if not otherwise indicated, the information provided in the following tables is compiled from the questionnaires. When this information has been completed or modified, footnotes with the reference can be found at the end of the section.

ALBANIA (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Only for POPs scope of the Stockholm Convention.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	National Implementation Plan for the Elimination of POPs.
Production / Import / Export					
	Year / Kg/year	Year / Kg/ ear	Year / Kg/year	Year / Kg/year	
Total annual **production**	N/A				
Total annual **imports**	N/A				
Total annual **exports**	N/A				
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	The stockpiles were removed in 2006.
Existence of contaminated sites	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	The contaminated side is currently under remediation.
Historic and current uses	Not used since early 90s.	N/A			
Waste management and recycling					
Waste management strategies	☐Yes ☒No ☐N/A	☐Yes ☒No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	

ALBANIA (Table 1)					
	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	2	- - -	- - -	- - -	N/A for those not specified.
Existence of studies, risk assessments and/or monitoring programmes	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

ALBANIA (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		National Implementation Plan for the Elimination of POPs.
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	1990	N/A	N/A						
Total annual **imports**	N/A								
Total annual **exports**	N/A								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of contaminated sites	☐Yes ☒No ☐N/A		☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Currently under remediation.
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		

ALBANIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	2	- - -	- - -	N/A for those not specified
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

ALGERIA (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks (a)
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		However, the NIP adaptation process has commenced: a training workshop was organized by the regional centre of Algeria to the Stockholm Convention with the participation of countries in the region of North Africa, which has allowed a detailed introduction to the procedures to be undertaken to update it.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Only reported strategies for identify stockpiles and or wastes of lindane. Not for products, articles or contaminated sites
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	Never produced in the country								According to preliminary research, 5 of the 9 pesticide chemicals are neither produced nor approved nor used except for lindane, which is used in pharmaceuticals. For other industrial chemicals, they are not exported, but only imported. Quantities involved are not yet all identified. This will be part of the National Implementation Plan updating.
Total annual **imports**	Reported imports of lindane, quantities unknown								
Total annual **exports**	Never exported from the country								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Stockpiles have not yet been identified. This will be part of the NIP updating process.
Existence of contaminated sites	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Historic and current uses	N/A		N/A		N/A		N/A		
Waste management and recycling									

ALGERIA (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks (a)
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

ALGERIA (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks (a)
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		However, the NIP adaptation process has commenced: a training workshop was organized by the regional centre of Algeria to the Stockholm Convention with the participation of countries in the region of North Africa, which has allowed a detailed introduction to the procedures to be undertaken to update it.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Only reported strategies for identify stockpiles and or wastes of lindane. Not for products, articles or contaminated sites
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	Never produced in the country								According to preliminary research, 5 of the 9 pesticide chemicals are neither produced nor approved nor used except for lindane, which is used in pharmaceuticals. For other industrial chemicals, they are not exported, but only imported. Quantities involved are not yet all identified. This will be part of the National Implementation Plan updating.
Total annual **imports**	Reported imports of lindane, quantities unknown								
Total annual **exports**	Never exported from the country								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☒No ☐N/A		☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of contaminated sites	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Historic and current uses	N/A		N/A		N/A		N/A		
Waste management and recycling									

ALGERIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks (a)
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

BOSNIA-and HERZEGOVINA (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		Law on Chemicals of the Republic of Srpska Entity Federal B&H Law of Chemicals is in process of preparation
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		Adoption of Chemical safety startegy is planned by Law on chemicals
Production / Import / Export									
	Year	Kg/year	Year	Kg/year	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production								
Total annual **imports**	No import								
Total annual **exports**	No export								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses									
Waste management and recycling									
Waste management strategies	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Environmentally sound	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

BOSNIA-and HERZEGOVINA (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
disposal of wastes					
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	---	---	---	---	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

BOSNIA and HERZEGOVINA (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		Law on Chemicals of the Republic of Srpska and Law on biocides of the Republic of Srpska
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		Adoption of Chemical safety startegy is planned by Law on chemicals
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production								
Total annual **imports**	No import								
Total annual **exports**	No export								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses									
Waste management and recycling									
Waste management strategies	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

BOSNIA and HERZEGOVINA (Table 2)					
	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

CROATIA (Table 1)									
	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		According to the information from the Ministry of Health and Social Welfare all nine new POPs are forbidden in the Republic of Croatia. Please see also information provided by Croatia in footnotes (b) and (c) at the end of the section.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		According to the information submitted by the relevant institutions and experts, there is no production, import, export or use of the above mentioned chemicals. Only Lindane was used until 2004. As it is now prohibited in the Republic of Croatia, it shall be assumed that it is no more in use.
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production								According to the information submitted by the relevant institutions and experts, there is no production, import, export or use of the new POPs. Only Lindane was used until 2004. As it is now prohibited in the Republic of Croatia. It must be assumed that it is no more in use.
Total annual **imports**	No import								
Total annual **exports**	No export								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of contaminated sites	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		It is assumed that there are no sites contaminated by lindane - the only substance that was used in the Republic of Croatia. For all the other new POPs, according to the information provided by relevant institutions, there are no sites contaminated by POPs.
Historic and current uses	N/A								
Waste management and recycling									

CROATIA (Table 1)					
	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	The Republic of Croatia doesn't possess disposal sites for hazardous waste so this type of waste is exported for disposal.
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues					

CROATIA (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production		2004	163 l	No production				According to the information submitted by the relevant institutions and experts, there is no production, import, export or use of the new POPs. Only Lindane was used until 2004. As it is now prohibited in the Republic of Croatia. It is assumed that it is no more in use. According to the register submitted by the companies to the Croatian Institute for Toxicology, in 2004 ca. 163 l of insecticide preparation containing Lindane was used (Gamacid T-50 – 500 g/l active substance Lindane, this product was used as plant protection product and Dendrolin-30 g/l active substance Lindane, this product was used as insecticide for wood protection). It is assumed that there is no more Lindane on stock.
Total annual **imports**	No imports								
Total annual **exports**	No exports								
Stockpiles, contaminated sites and uses									

CROATIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Existence of stockpiles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of contaminated sites	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	It is assumed that there are no sites contaminated by lindane - the only substance that was used in the Republic of Croatia. For all the other new POPs, according to the information provided by relevant institutions, there are no sites contaminated by POPs.
Historic and current uses	N/A	Plant and wood protection	N/A	N/A	In 2004 ca. 163 l of insecticide preparation containing Lindane was used (Gamacid T-50 – 500 g/l active substance Lindane, this product was used as plant protection product and Dendrolin-30 g/l active substance Lindane, this product was used as insecticide for wood protection)
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	The Republic of Croatia doesn't possess disposal sites for hazardous waste so this type of waste is exported for disposal.
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	

CROATIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

CYPRUS (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		An amendment of the National Legislation in relation to the Stockholm Convention has been submitted for legal vetting in order to include the new POPs. In addition, once an article is categorised as waste then its management is governed by the Solid and Hazardous Law. Under this law, the procedures of collection, transport, treatment, export and/or disposal are controlled. No management specifications exist for each POP substance. The general conditions for hazardous waste management apply.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Cyprus has not developed such strategies yet. As a start point a mechanism for identifying the presence of POPs in products and articles is required. Until a mechanism is established for identifying products / articles that contain these substances, it is difficult to identify stockpiles and/or wastes. Until a mechanism is established for identifying products / articles that contain these substances, it is difficult to identify possible sites and verify or not their contamination.
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production								
Total annual **imports**	1998	445	No import						Imported in pure form as total HCH from United Kingdom.
Total annual **exports**	No exports								
Stockpiles, contaminated sites and uses									

CYPRUS (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Existence of stockpiles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of contaminated sites	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Historic and current uses					
Waste management and recycling					
Waste management strategies	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	
Environmentally sound disposal of wastes	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	Wastes containing or consisting of any of the new POPs are not identified or known. All suspicious waste is handled as hazardous and treated accordingly. If management in the country is not possible, the waste is exported according to the relevant law.
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Only parts from Waste Electrical and Electronic Equipment (WEEE) and where this is applicable, with POPs content unknown.
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	There is no data / evidence available regarding the presence of the new POPs in various articles. Such data are needed in order to proceed with further actions.
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	The main difficulty to proceed with further actions is to identify the presence of the new POPs in products/articles. In Cyprus there is no production of articles such as electronic equipment, wire and cables or articles used in the transportation sector. Most articles listed in the Annexes are imported. In case of any				

CYPRUS (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
	production most of the raw materials used are also imported. Therefore, it is necessary to establish mechanisms for identifying such articles and ban their import if they are found to contain the POPs listed in the Stockholm Convention.				

CYPRUS (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	An amendment of the National Legislation in relation to the Stockholm Convention has been submitted for legal vetting in order to include the new POPs. In addition, once an article is categorised as waste then its management is governed by the Solid and Hazardous Law. Under this law, the procedures of collection, transport, treatment, export and/or disposal are controlled. No management specifications exist for each POP substance. The general conditions for hazardous waste management apply.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Cyprus has not developed such strategies yet. As a start point a mechanism for identifying the presence of POPs in products and articles is required. Until a mechanism is established for identifying products / articles that contain these substances, it is difficult to identify stockpiles and/or wastes. Until a mechanism is established for identifying products / articles that contain these substances, it is difficult to identify possible sites and verify or not their contamination.
Production / Import / Export					

CYPRUS (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production								
Total annual **imports**	No import		2007	48	No import				Imported from Germany as pure form.
			2009	38					Imported from Netherlands as pure form.
Total annual **exports**	No exports								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of contaminated sites	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		
Environmentally sound disposal of wastes	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		Wastes containing or consisting of any of the new POPs are not identified or known. All suspicious waste is handled as hazardous and treated accordingly. If management in the country is not possible, the waste is exported according to the relevant law.
Recycling of articles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Only parts from Waste Electrical and Electronic Equipment (WEEE) and where this is applicable, with POPs content unknown.
Alternatives, research and monitoring programmes, and emerging issues									
Research programmes on	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

CYPRUS (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
development of alternatives					
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	There is no data / evidence available regarding the presence of the new POPs in various articles. Such data are needed in order to proceed with further actions.
Level of substitution (0, 1, 2)	---	---	---	---	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	The main difficulty to proceed with further actions is to identify the presence of the new POPs in products/articles. In Cyprus there is no production of articles such as electronic equipment, wire and cables or articles used in the transportation sector. Most articles listed in the Annexes are imported. In case of any production most of the raw materials used are also imported. Therefore, it is necessary to establish mechanisms for identifying such articles and ban their import if they are found to contain the POPs listed in the Stockholm Convention.				

FRANCE (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	Chlordecone and HBB are regulated by EU Regulation No. 850/2004 on persistent organic pollutants. They are listed in Annex I: ban on production, placing on the market and utilization of those substances as such, in preparations or articles. C-PentaBDE is a commercial mixture consisting of tetraBDE and pentaBDE. PentaBDE is regulated by Regulation No 1907/2006 (REACH). It is listed in Annex XVII (entry 44): prohibiting the placing on the market and use as a substance or in mixtures at concentrations above 0.1% by weight, banning to put on the market articles containing the substance in more than 0.1% by weight, there are some exceptions. Alpha- and beta-HCH are not regulated as such. Technical HCH (CAS No. 608-73-1) in contrast, is regulated by Regulation No. 850/2004 (Annex I).
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	For chlordecone and HBB, provisions to this effect exist in Regulation No 850/2004 (Article 5 on stocks, Article 7 on management of waste). Note that some of these substances are being used as part of a research program of dangerous substances in water that contributes to the implementation of the Water Framework Directive No. 2000/60 (http://rsde.ineris.fr/ : see the flyers from February 4, 2002 and January 5, 2009). The management of pollution in the French Antilles of chlordecone has been assessed under a particular plan www.chlordecone-infos.fr. Data on contaminated land is available at: http://basol.ecologie.gouv.fr/

FRANCE (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	2008	< 1 t/a	2008	0	2008	0	2008	< 1 t/a	On chlordecone and HBB: no non-compliance with the prohibition known.
	2009	< 1 t/a	2009	0	2009	0	2009	< 1 t/a	
Total annual **imports**	2008	Possible: goods likely to contain	2008	0	2008	0	N/A	N/A	Data on Import / Export activities are considered confidential by the French customs authorities. The figures can not be disclosed. In general, they are to be considered with great caution as there is no exact correspondence between the customs codes and CAS numbers of substances (code corresponds to several substances) and these figures do not show whether the imports / exports were made under the exemptions provided for existing regulations.
	2009	Possible: substances as such and goods likely to contain	2009	Possible: substance as such	2009	0	N/A	N/A	
Total annual **exports**	2008	Possible: goods likely to contain	2008	0	2008	0	N/A	N/A	
	2009	Possible: goods likely to contain	2009	Possible: substance as such	2009	0	N/A	N/A	
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		For chlordecone and HBB: no notification has been received of stocks pursuant to Article 5 of Regulation 850/2004. In the absence of contrary information available, it is deduced that there are no stocks of these substances.

FRANCE (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
					For C-PentaBDE: it may be present in some items still on the market. One source reports 330,000 tones of HCH remaining in the country (g).
Existence of contaminated sites	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	See data available at: www.chlordecone-infos.fr http://basol.ecologie.gouv.fr/
Historic and current uses	By-product in lindane production	Insecticide	Fire-resistant agent	Flame retardant	
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	For chlordecone and HBB, Article 7 of Regulation No 850/2004 laying down conditions for management of waste containing these substances. There are channels for waste recovery likely to contain penta-BDE C (recycling of waste plastics from waste electrical and electronic equipment).
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	For chlordecone and HBB, Article 7 of Regulation No 850/2004 laying down conditions for management of waste containing these substances. Storage is possible in certain conditions (Annex V).
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☒Yes ☐No ☐N/A	There are channels for waste recovery may contain C-penta (recycling of waste plastics from waste electrical and electronic equipment).

FRANCE (Table 1)					
	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	As part of their inclusion in the appendices of Aarhus Protocol on POPs to the Convention on the Long Range Transboundary Air Pollution, chlordecone, HBB and the C-PentaBDE have been the subject of an analysis of alternatives (http://www.unece.org/env/lrtap/TaskForce/popsxg/welcome.html). It is the same for all substances in their recent listing in the Annexes to the Stockholm Convention.
Level of substitution (0, 1, 2)	- - -	2	- - -	- - -	
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

FRANCE (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	The octa-BDE regulated in Annex XVII of REACH (entry 45) does not match the commercial mixture. Lindane is regulated by the European Regulation No. 850/2004 on persistent organic pollutants. It is listed in Annex I: ban on production, placing on the market and utilization of substances as such, in preparations or articles. PFOS are regulated by Regulation No 1907/2006 (REACH). They are listed in Annex XVII (entry 53): ban with many exceptions.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	For lindane, provisions in this direction exist in Regulation No 850/2004 (Article 5 on stocks, Article 7 on management of waste). For PFOS, there is a decree of November 26, 2008 on the annual declaration to the Administration of manufacturers, importers or users of PFOS (http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000019872071). Note that some of these substances are being used as part of a research program of dangerous substances in water that contributes to the implementation of the Water Framework Directive No. 2000/60 (http://rsde.ineris.fr/: see the flyers from February 4, 2002 and January 5, 2009). Data on contaminated land are available at: http://basol.ecologie.gouv.fr/

FRANCE (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A	N/A	2008	0	2008	> 1 t/a		0	On lindane: no non-compliance with the prohibition known. PFOS are not produced in France.
	N/A	N/A	2009	0	2009	> 1 t/a		0	
Total annual **imports**	N/A	N/A	2008	Possible: goods likely to contain	N/A	N/A	N/A	N/A	
	N/A	N/A	2009	Possible: substance as such and goods likely to contain	N/A	N/A	N/A	N/A	
Total annual **exports**	N/A	N/A	2008	Proven case of export of substance Possible: goods that may contain	N/A	N/A	N/A	N/A	A thorough investigation based on customs data showed an illegal export of lindane for which the company concerned has had to initiate corrective actions.
	N/A	N/A	2009	Possible: goods likely to contain	N/A	N/A	N/A	N/A	

FRANCE (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☐No ☒N/A	☐Yes ☒No ☐N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	For lindane: no notification has been received of stocks pursuant to Article 5 of Regulation No 850/2004. In the absence of contrary information available, it can be deduced that there is no more inventory of this substance. However, one source reports 330,000 tones of HCH remaining in the country (g). The annual declaration for 2008 on PFOS has shown that there is stock but quantities are difficult to assess.
Existence of contaminated sites	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	See data available at: www.chlordecone-infos.fr http://basol.ecologie.gouv.fr/
Historic and current uses	Flame retardant	Insecticide and industrial chemical product	Industrial chemical product and fungicide	Multiple uses listed in Annex XVII of REACH (entry 53). The annual declaration for 2008 identified the following uses: - Product of hard chromium - Photoresists or anti-reflective coatings - Fire-fighting foams (emulsions)	
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	For lindane, Article 7 of Regulation No 850/2004 laying down conditions for management of wastes containing the substance. There are channels for recovery of waste that may contain C-octa-BDE (recycling of waste plastics from

FRANCE (Table 2)					
	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
					waste electrical and electronic equipment).
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	For lindane, Article 7 of Regulation No 850/2004 laying down conditions for management of wastes containing the substance. Storage is possible in certain conditions (Annex V).
Recycling of articles	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	There are channels for recovery of waste which may contain C-octa-BDE (recycling of waste plastics from waste electrical and electronic equipment). Waste containing PFOS is likely to be recycled.
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	There are uses of PFOS for which there are no alternatives.
Level of substitution (0, 1, 2)	- - -	2	- - -	- - -	
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

ISRAEL (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Legal framework					
Existence of a national legal framework	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	Hazardous Substances Law, 1993 - For industrial chemicals Plant Protection Law, 1956 - For pesticides
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Production / Import / Export					
	Year / Kg/year	Year / Kg/ ear	Year / Kg/year	Year / Kg/year	
Total annual **production**	N/A				
Total annual **imports**	N/A				
Total annual **exports**	N/A				
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of contaminated sites	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Historic and current uses	None reported				
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	According EU Directive EC/2008/98
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	

ISRAEL (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	Starting the development of the National Implementation Plan				

ISRAEL (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	Hazardous Substances Law, 1993 - For industrial chemicals Plant Protection Law, 1956 - For pesticides
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	
Production / Import / Export					

ISRAEL (Table 2)									
	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A								
Total annual **imports**	N/A								
Total annual **exports**	N/A								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		According EU Directive EC/2008/98
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Recycling of articles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Alternatives, research and monitoring programmes, and emerging issues									
Research programmes on development of alternatives	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of alternatives	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Level of substitution (0, 1, 2)	- - -		- - -		- - -		- - -		N/A

ISRAEL (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	Starting the development of the National Implementation Plan				

MALTA (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	2006-2009	0	2006-2009	0	2006-2009	0	2006-2009	0	None of these chemicals were produced in Malta.
Total annual **imports**	2006	5	2006	0	2006	0	2006	0	Data on 1,2,3,4,5,6-Hexachlorocyclohexane could not be broken down between a-HCH, ß-HCH and lindane (γ-HCH). Therefore the amounts shown include a-HCH, ß-HCH and also lindane (γ-HCH). Besides, there was no import into Malta of Chlordecone, HBB nor C-pentaBDE.
	2007	171	2007	0	2007	0	2007	0	
	2008	55	2008	0	2008	0	2008	0	
	2009	225	2009	0	2009	0	2009	0	
Total annual **exports**	2006-2009	0	2006-2009	0	2006-2009	0	2006-2009	0	None of these chemicals were exported from Malta.
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								

MALTA (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Waste management and recycling					
Waste management strategies	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	N/A
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

MALTA (Table 2)									
	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	2006-2009	0	2006-2009	0	2006-2009	0	2006-2009	0	None of these chemicals were produced in Malta.
Total annual **imports**	2006-2009	0	2006-2009	0	2006-2009	0	2006-2009	0	Data on 1,2,3,4,5,6-Hexachlorocyclohexane could not be broken down between a-HCH, ß-HCH and lindane (γ-HCH). Therefore the amounts shown include a-HCH, ß-HCH and also lindane (γ-HCH). Besides, there was no import into Malta of C-octaBDE, Pentachlorobenzene nor PFOS & PFOS-F.
Total annual **exports**	2006-2009	0	2006-2009	0	2006-2009	0	2006-2009	0	None of these chemicals were exported from Malta.
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

MALTA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Historic and current uses	None reported				
Waste management and recycling					
Waste management strategies	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A	☐Yes ☒No ☒N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	No chemical wastes containing the above mentioned chemicals are generated within the Maltese Islands.
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

MONACO (Table 1)					
	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Production / Import / Export					
	Year / Kg/year	Year / Kg/ ear	Year / Kg/year	Year / Kg/year	
Total annual **production**	N/A				Information from the past not currently available
Total annual **imports**	N/A				
Total annual **exports**	N/A				
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Existence of contaminated sites	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Historic and current uses	None reported				
Waste management and recycling					
Waste management strategies	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco

MONACO (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Existence of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Emerging issues	None reported				

MONACO (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Not applicable in Monaco
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		Not applicable in Monaco
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A								Information from the past not currently available
Total annual **imports**	N/A								
Total annual **exports**	N/A								

MONACO (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Existence of contaminated sites	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Historic and current uses	None reported				
Waste management and recycling					
Waste management strategies	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Recycling of articles	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Existence of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Level of substitution (0, 1, 2)	---	---	---	---	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	Not applicable in Monaco
Emerging issues	None reported				

MOROCCO (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A								
Total annual **imports**	N/A						2010	9111	This quantity corresponds in mattered of octa- + penta-BDE
Total annual **exports**									
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Recycling of articles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Alternatives, research and monitoring programmes, and emerging issues									

MOROCCO (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

MOROCCO (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Production / Import / Export					

MOROCCO (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A								
Total annual **imports**	2010	9111	2010	N/A	2010	202	2010	2335	The data 9111 kg imported in 2010 corresponds to penta- + octa-BDE. Information relative to the quantity of Lindane imported is not available at the moment.
Total annual **exports**	N/A								
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		Lindane stockpiles cited in (d)
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Environmentally sound disposal of wastes	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Recycling of articles	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Alternatives, research and monitoring programmes, and emerging issues									

MOROCCO (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Research programmes on development of alternatives	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	☐Yes ☒No ☐N/A	
Emerging issues	None reported				

SLOVENIA (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Total annual **imports**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Total annual **exports**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

SLOVENIA (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☒No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	
Emerging issues	None reported				

SLOVENIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A	☐Yes ☒No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	

SLOVENIA (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Total annual **imports**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Total annual **exports**	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	2007 – 2009	0	
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Historic and current uses	None reported								
Waste management and recycling									
Waste management strategies	☐Yes ☐No ☒N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☐No ☒N/A		
Environmentally sound disposal of wastes	☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		
Recycling of articles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Alternatives, research and monitoring programmes, and emerging issues									
Research programmes on development of alternatives	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		

SLOVENIA (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

SPAIN (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Legal framework					
Existence of a national legal framework	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	Chlordecone and HBB are regulated by EU Regulation No. 850/2004 on persistent organic pollutants. C-PentaBDE is regulated by Regulation No 1907/2006 (REACH). It is listed in Annex XVII (entry 44): prohibiting the placing on the market and use as a substance or in mixtures at concentrations above 0.1% by weight, banning to put on the market articles containing the substance in more than 0.1% by weight, there are some exceptions. Alpha- and beta-HCH are not regulated as such. Technical HCH (CAS No. 608-73-1) in contrast, is regulated by Regulation No. 850/2004 (Annex I). All the new POPs are regulated by Regulations (EC) 756/2010 and 757/2010 in the European Union Member States.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	For chlordecone and HBB, provisions to this effect exist in Regulation No 850/2004 (Article 5 on stocks, Article 7 on management of waste).

Production / Import / Export	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A		N/A		No production		No production		
Total annual **imports**	N/A		N/A		No imports		N/A		
Total annual **exports**	N/A		N/A		No exports		No exports		

SPAIN (Table 1)					
	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Stockpiles, contaminated sites and uses					
Existence of stockpiles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of contaminated sites	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Historic and current uses	N/A		Flame retardant in plastics and textile.		
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	Regulation (EC) 756/2010 establishes provisions on waste management for all the new POPs in the EU Member States.
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	
Level of substitution (0, 1, 2)	- - -	- - -	2	- - -	According to the Spanish NIP, products containing HBB manufactured in the past could still be in use.
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

SPAIN (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Legal framework									
Existence of a national legal framework	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		Lindane is regulated by the European Regulation No. 850/2004 on persistent organic pollutants. It is listed in Annex I: ban on production, placing on the market and utilization of substances as such, in preparations or articles. PFOS are regulated by Regulation No 1907/2006 (REACH). They are listed in Annex XVII (entry 53): ban with many exceptions. All the new POPs are regulated by Regulations (EC) 756/2010 and 757/2010 in the European Union Member States.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		For lindane, provisions in this direction exist in Regulation No 850/2004 (Article 5 on stocks, Article 7 on management of waste).
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	No production		No production		No production		N/A		
Total annual **imports**	N/A		2005	4000	No import		N/A		Lindane: data from Spanish NIP. It is assumed that these imports no longer occur.
Total annual **exports**	No exports		N/A		No export		N/A		
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		Contaminated sites in Basque Country and Huesca, most of them already de-contaminated or with projects undergoing (according to the 2007 Spanish NIP).

SPAIN (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Historic and current uses	N/A	Pesticide	Fungicide, flame retardant and in dielectric fluids.	Multiple uses	More information in the Spanish NIP.
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	
Level of substitution (0, 1, 2)	- - -	2	- - -	1	
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

TURKEY (Table 1)

	α-HCH & β-HCH		Chlordecone		HBB		C-pentaBDE		Remarks
Legal framework									
Existence of a national legal framework	☒Yes ☐No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		☐Yes ☒No ☐N/A		HCH (and its isomers) is subject to the Turkish By-Law on “Control of Pollution Caused By Dangerous Substances in Aquatic Environment” (Annex I), which regulates industrial wastewater discharges that may contain certain dangerous substances. Other new POPs may be included in future revisions of the By-Law.
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		Studies for identifying and managing sites contaminated by POPs are still being carried on. Further details may be given as soon as those studies yield results.
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	0		N/A						No production of α-HCH (f)
Total annual **imports**	N/A								
Total annual **exports**	2008	209	N/A		2008	2695	N/A		
	N/A		2009	491	2009	4250	N/A		
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		
Existence of contaminated sites	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		It is known that there are a number of sites contaminated by POPs. However, more detailed investigations should be carried out for determining what percentages of those sites are contaminated by the new POPs. The existing studies on

TURKEY (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
					identifying and managing sites contaminated by POPs are still being carried on. Further details may be given as soon as those studies yield some results.
Historic and current uses					
Waste management and recycling					
Waste management strategies	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	Two of the new POPs given in Stockholm Convention (Pentachlorobenzene and Pentabromodiphenylether) are listed in Annex 2 of the Turkish By-Law on "Control of Pollution Caused By Dangerous Substances in Aquatic Environment", which regulates industrial wastewater discharges that may contain certain dangerous substances. In addition to those two substances, hexachlorocyclohexane (alpha & beta hexachlorocyclohexane are isomers of HCH) is also listed in Annex-I of the abovementioned By-Law. Although it is a big step to issue such a By-Law on the way of preventing and controlling pollution caused by certain dangerous substances, there are still some inadequacies. Environmental Quality Standards (EQS) and Discharge Standards for Annex-2 substances, including Pentachlorobenzene and Pentabromodiphenylether, are not known. They will be determined as a result of a national project to be started in this year. Afterwards, full implementation of the By-Law would be possible and a revision, which aims to include new POPs into the By-Law, would be realized.
Environmentally sound disposal of wastes	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	

TURKEY (Table 1)

	α-HCH & β-HCH	Chlordecone	HBB	C-pentaBDE	Remarks
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues					

TURKEY (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Legal framework					
Existence of a national legal framework	☐Yes ☒No ☐N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☒No ☐N/A	Pentachlorobenzene is subject to the Turkish By-Law on “Control of Pollution Caused By Dangerous Substances in Aquatic Environment”, which regulates industrial wastewater discharges that may contain certain dangerous substances. In addition, HCH (and its isomers) is also listed in Annex-I of the above mentioned By-Law. Other new POPs may be included in future revisions of the By-Law.

TURKEY (Table 2)

	C-octaBDE		Lindane		PeCB		PFOS & PFOS-F		Remarks
Existence of strategies for identifying/manage products, articles, stockpiles, wastes and/or sites contaminated	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		Studies for identifying and managing sites contaminated by POPs are still being carried on. Further details may be given as soon as those studies yield results.
Production / Import / Export									
	Year	Kg/year	Year	Kg/ ear	Year	Kg/year	Year	Kg/year	
Total annual **production**	N/A				No production		N/A		No production of PeCB (e)
Total annual **imports**	N/A								
Total annual **exports**	N/A		Since 2008	314.440	N/A				Approximately 3000 tones HCH (lindane) have been stored in Derince-KOCAELI since 1985. Several researches have been done for disposing this material in Turkey. Turkey does not have the technical capacity to dispose of or recycle this waste in an environmentally sound manner. This waste has being exported to Germany since 2008 according to Basel Convention's procedures. Up to now 314.440 kg HCH was exported. Due to lack of financial resources exporting process stopped now.
Stockpiles, contaminated sites and uses									
Existence of stockpiles	☐Yes ☐No ☒N/A		☒Yes ☐No ☐N/A		☐Yes ☐No ☒N/A		☐Yes ☐No ☒N/A		Approximately 3000 tones HCH (lindane) have been stored in Derince-KOCAELI since 1985. Several researches have been done for disposing this material in Turkey. Turkey does not have the technical capacity to dispose of or recycle this waste in an environmentally sound manner. This waste has being exported to Germany since 2008 according to Basel Convention's procedures. Up to now 314.440 kg HCH was exported. Due to lack of financial resources exporting process stopped now. This amount of lindane stockpiles is also cited in (g).
Existence of contaminated sites	☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		☒Yes ☐No ☐N/A		It is known that there are a number of sites contaminated by POPs. However, more detailed

TURKEY (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
					investigations should be carried out for determining what percentages of those sites are contaminated by the new POPs. The existing studies on identifying and managing sites contaminated by POPs are still being carried on. Further details may be given as soon as those studies yield some results.
Historic and current uses	None reported				
Waste management and recycling					
Waste management strategies	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	Two of the new POPs given in Stockholm Convention (Pentachlorobenzene and Pentabromodiphenylether) are listed in Annex 2 of the Turkish By-Law on “Control of Pollution Caused By Dangerous Substances in Aquatic Environment”, which regulates industrial wastewater discharges that may contain certain dangerous substances. In addition to those two substances, hexachlorocyclohexane (alpha & beta hexachlorocyclohexane are isomers of HCH) is also listed in Annex-I of the abovementioned By-Law.

TURKEY (Table 2)

	C-octaBDE	Lindane	PeCB	PFOS & PFOS-F	Remarks
Environmentally sound disposal of wastes	☐Yes ☐No ☒N/A	☒Yes ☐No ☐N/A	☒Yes ☐No ☐N/A	☐Yes ☐No ☒N/A	Although it is a big step to issue such a By-Law on the way of preventing and controlling pollution caused by certain dangerous substances, there are still some inadequacies. Environmental Quality Standards (EQS) and Discharge Standards for Annex-2 substances, including Pentachlorobenzene and Pentabromodiphenylether, are not known. They will be determined as a result of a national project to be started in this year. Afterwards, full implementation of the By-Law would be possible and a revision, which aims to include new POPs into the By-Law, would be realized.
Recycling of articles	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Alternatives, research and monitoring programmes, and emerging issues					
Research programmes on development of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Existence of alternatives	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Level of substitution (0, 1, 2)	- - -	- - -	- - -	- - -	N/A
Existence of studies, risk assessments and/or monitoring programmes	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	☐Yes ☐No ☒N/A	
Emerging issues	None reported				

Notes:

(a) Information for **Algeria** has been completed with the questionnaire sent to the Secretariat of the Stockholm Convention following the information request adopted by Decision SC 4/19

(b) **Croatian position regarding inclusion of Aldrin, Chlordane, Dieldrin, Endrin, Heptachlore, Mirex, Toxaphene and DDT**.

Besides being Contracting Party to Barcelona Convention, Croatia also signed and ratified (OG International Treaties 2/2007) the Stockholm Convention on Persistent Organic Pollutants which entered into forces as regards the Republic of Croatia on April 30, 2007. As one of obligations of Stockholm Convention is the adoption of a National plan for its implementation which Croatian Government adopted by a 'Decision on adoption of a National Plan for Implementation of Stockholm Convention on Persistent Organic Pollutants' (OG 145/2008) on its session held on December 5th , 2008. According to the above mentioned National Plan, there is no production, import, export or use of POPs pesticides in Croatia, which is in compliance with legislation in force. The use of Chlordane was prohibited in 1971, Aldrin, Dieldrin and DDT in 1972, HCB in 1980 and Toxaphene in 1982. DDT synthesis in Croatia has never been present, but the preparation of different formulations existed. DDT use in purpose of disease vector control has never been present, as there have been no cases of malaria in Croatia in the last 50 years. The application and use of Dicofol are prohibited. The last prohibited compound was Endrin in 1989, while the usage of Mirex has never been allowed in Croatia. The inventory of POPs pesticides, stockpiles or contaminated sites were not detected. No POPs pesticides are in production in Croatia, nor there are any active compounds, which could be used for their production or import. List of active substances from the group of pesticides classified as POPs and the years of their prohibition:

Active substance	Allowed from	Prohibited from
Aldrin	1958	1972
DDT	1944	1972 in agriculture
Dieldrin	1958	1972
Endrin	1957 (from 1971 only as rodenticide)	29 May 1989
HCB	1962	11 July 1980
Heptachlore	1956	July 1973
Chlordane	No available data before 1955	1971
Mirex	Has never been allowed for use in the Republic of Croatia	
Toksafen	1957	27 April 1982
Dikofol	1949	2001
HCH	1944	1972
Kelevan	18 December 1969	31 December 1977

According to legal regulations, environmental levels of POPs pesticides are monitored in waters only, while for other elements of environment monitoring is not obligatory. Data on POPs level in environment are being collected through various projects and from the analysis of inspection samples. Unfortunately this is not done permanently and within a national monitoring programme. From above mentioned, it is evident that POPs pesticides do not represent a problem in Croatia and their systematic monitoring (which is represented in the Action Plan) is enabling timely reaction to possible cross-border pollution with POPs from neighbouring countries.

(c) Legal framework in **Croatia**

Chemical	**Description of the framework (*e.g., entry into force, aspects included, concerned entities, etc.*)**	**Reference**
Alfa hexachlorocyclohexane (α-HCH) and **beta hexachlorocyclohexane** (β-HCH)	The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	OG-IT 4/07
	Act on Plant Protecting Agents	OG 70/05
Chlordecone	Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants, Annex I	OG-IT 5/07
	Act on Plant Protecting Agents	OG 70/05
Hexabromobiphenyl (HBB)	Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants, Annex I	OG-IT 5/07
Commercial Pentabromodiphenylether (penta-DBE)	List of Hazardous Chemicals Whose Market is Prohibited or Limited, Article 1. point 44	OG 17/06
Commercial Octabromodiphenylether (octa-BDE)	List of Hazardous Chemicals Whose Market is Prohibited or Limited, Article 1. point 45	OG 17/06
Lindane (γ-HCH)	The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	OG-IT 4/07
	Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Persistent Organic Pollutants, Annex I	OG-IT 05/07
	Decision on prohibition of placing on the market of PPPs containing active substance lindane, July 2001	
	Act on Plant Protecting Agents	OG 70/05
Pentachlorobenzene (PeCB)	-	-
Perfluorooctane sulfonic acid (PFOS), its salts and **perfluoroctane sulfonyl fluoride** (PFOS-F)	-	-

(d) UNEP, 2008a

(e) UNEP, 2007d

(f) UNEP, 2007a

(g) IHPA, 2010

9. Conclusions

In view of the information compiled through the bibliographic research and previous studies on POPs, and of the data gathered through the questionnaires sent by the relevant national authorities, the following conclusions are established for this diagnosis:

1. Actual data on the new POPs regarding the countries party to the Mediterranean Action Plan is scarce and very scattered through several studies and reports.

2. Regarding the **legal framework**, managing strategies and progresses made towards the elimination of the new POPs are different for MAP EU Member States countries and those not being members of the European Union.

3. EU Members have strategies and mechanisms already in place to manage all the new POPs, and have banned their use or have established a schedule for the phasing out.

4. As a general approach, the situation for non-EU MAP countries is less clear: some of them report to have EU legislation as a model to follow, but not all the new POPs are covered by national regulations.

5. MAP Parties considered as developing countries or countries with economies in transition face several problems in adapting their legal framework to comply with international agreements. Furthermore, most of them cannot even succeed in developing monitoring programmes to evaluate the actual situation of production, use, stockpiles, waste or contaminated sites, mainly due to the lack of financial or technical capacity.

6. With regard to the availability of **substitutes**, both alternative chemicals and alternative process are feasible at a global scale (except some specific uses of some substances). Thus, it can be assumed that the substitution at a regional level is possible, although it might face some barriers to overcome such as extra costs of the alternative substances or processes (in some cases) and technical suitability. Other impediments can arise from deeper and sometimes more difficult obstacles to subdue like inadequate or inexistent training and communication strategies that can lead to social impediments against the substitution process among the stakeholders involved.

7. **Waste management** is carried out in an environmentally sound manner when the appropriate legal framework exists. The information obtained does not allow to state clearly if wastes from the new POPs are properly managed in non-EU MAP countries. In the EU Member States, the national and regional authorities exert a tight control over producers to ensure the ESM of wastes, so it can be assumed that most of them are managed according the legal principles.

8. Regarding the **stockpiles**, although some countries are in position to confirm their existence or absence, in many cases the information is not available due to the lack of monitoring programmes.

9. There are some historically identified cases of **contaminated sites** for some countries, but for the majority of them very little information is available. However, independent studies lead to believe that due to the past utilization of some of the new POPs (mostly in the case of pesticides), sites might arise in the future when proper evaluations are carried out.

10. The low success rate in the questionnaire's responses, despite the efforts made and the exhaustive follow up, can denote a lack of actual knowledge on new POPs in the region.

10. Proposals at regional level

As it has been mentioned before, actual situation regarding the management of the new POPs is very different in EU Member States MAP countries and in non-EU Members.

For EU Members, the activities should aim to the compliance of current EU legislation and the phasing out schedule of some of the new POPs. Since not many MAP EU Members submitted the questionnaire, it is difficult to determine national realities. However, some of the questionnaires reported not knowledge on several important aspects about some of the new POPs, such as the existence of a national regulation, stockpiles, contaminated sites or even ESM of wastes. With the listing of these substances to the Stockholm Convention, this lack of data in some areas should be solved establishing control mechanisms to retrieve up to date information that allows absolute knowledge of these substances in the country.

These countries should also be prepared to provide financial and technical support to those other countries with limited capabilities to develop the appropriate strategies towards the elimination of the new POPs without external assistance.

In non-EU Members, where the level of management strategies and knowledge on the situation is, in many cases, unclear, efforts should be put in early stages on the establishment of management strategies, such as the development of monitoring activities to achieve an understanding of the reality of these substances in the country, as a first step towards building a legal framework robust, nation-wide applicable and adapted to the countries' needs. Among this group of MAP parties, developing countries face bigger problems due to the lack of technical and financial capacity to confront such activities. Thus, they should be the initial focus of capacity building activities that could be developed at three stages, as displayed in Table 26.

Table 26. Capacity building activities in developing countries.

Up-stream	Mid-stream	Down-stream
- Analysis and updating of data on use, production, export and import of the new POPs. - Accounting for amounts stored in the country. - Legislative measures for dealing with the new POPs (PIC procedure, time-bound phasing out, incentives to use safer products, environmental tax, etc.). - Prioritization of activities to be carried out. - Setting up coordination mechanism among stakeholders. - Promoting national and regional networking and exchange of information.	- Standardization of objectives and mechanisms to achieve them. - Training of staff and implementation of rules and regulations. - Implementation of legislative measures.	- Establishment of physical facilities with trained personnel. - Carrying out monitoring activities needed to contain/eliminate the new POPs along with other chemicals of concern at the field level. - Assess POP levels is in the environment as pure compounds and major toxic/persistent metabolites. - Asses the level of volatilization. - Evaluate possible ground and surface water contamination events. - Breakdown of the new POPs in the environment (and to what compounds). - Determine actions taken to contain/ decontaminate POPs. - Disposal options for the new POPs in storage. - Evaluate the availability of alternative methods or substitutes.

Source: adapted from UNIDO, 2010.

The decisions on the new POPs entered into force on 26 August 2010, one year after the communication by the Depositary of the adoption of the amendments, for the 152 of the 172 Parties to the Stockholm Convention that have not submitted a notification or a declaration, respectively in accordance with paragraphs 3 and 4 of Article 22 of the Convention. No notifications of non-acceptance were received by the Depositary to that date. The other 20 Parties, in accordance with paragraph 4 of Article 25 of the Convention, have declared in their instruments of ratification, acceptance, approval or accession to become a Party to the Convention, that they were bound to any amendment to Annexes A, B or C only upon deposit of their instruments of ratification, acceptance, approval or accession with respect to the amendments. No such instruments had been deposited with the Depositary to that date.

Parties should start the process of updating their National Implementation Plans (NIP), in conformity with Article 7, that establishes that the revised NIPs shall be transmitted to the Conference of the Parties within two years of the entry into force of the amendments to the Convention, i.e. before 26 August 2012. On doing so, they should take advantage of their previous experience and lessons learned from their initial NIP work for the initial 12 POPs.

When updating its NIP, a Party will need to identify relevant objectives and goals, and develop action plans for the nine new POPs as appropriate. Existing publications and tools, such as UNITAR´s guidelines to support the elaboration of NIPs, or several documents by other chemicals-related convention provide guidance that is useful for updating NIPs. Some examples are[10]:

- Guidance for developing a National Implementation Plan for the Stockholm Convention
- Lessons learned and good practices in the development of national implementation plans for the Stockholm Convention on Persistent Organic Pollutants
- Guidance material on New POPs (draft version)

For those countries with little knowledge on the status of the new POPs in their territory, an initial assessment is required. An exhaustive assessment of prior national studies should be made, since it is possible that they have been carried out by independent national or international organizations. The CP/RAC, as Regional Centre under the Stockholm Convention, can assist them in the implementation of the Convention.

Finally, it should not be overlooked the importance of promoting cooperative reinforcement activities among all the international agreements related to hazardous substances, like the Rotterdam and Basel Convention, the LRTAP Protocol, OSPAR Commission or SAICM, among others.

[10] Available at:
http://chm.pops.int/Convention/Media/Publications/tabid/506/language/es-CO/Default.aspx

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13. ANNEXES

ANNEX I: Overview of use of alternative flame retardants to PentaBDE in several materials and applications. *Source: UNEP, 2009b.*

Materials/polymers/resins	Inorganic alternatives to PentaBDE	Phosphorus/nitrogen organic alternatives to PentaBDE	Halogen organic alternatives to PentaBDE	Alternative flame retardant materials	Applications	Commercial commodities for the applications
Epoxy resins	Aluminium hydroxide (ATH) Magnesium hydroxide Ammonium poly phosphate Red phosphorus	Metallic phosphinates Reactive nitrogen and phosphorus constituents (unspecified) DOPO[13]	Tetrabromobis phenol A (reactive) Etylenebis (tetrabromo) phtalimid	Polyethylene sulphide	Circuit boards, protective coatings	Computers, ship interiors, electronic parts.

[13] DOPO=Dihydrooxaphosphaphenanthrene oxide

Materials/polymers/resins	Inorganic alternatives to PentaBDE	Phosphorus/nitrogen organic alternatives to PentaBDE	Halogen organic alternatives to PentaBDE	Alternative flame retardant materials	Applications	Commercial commodities for the applications
	Zinc hydroxystannate (ZHS), Zinc stannate (ZS) & ZHS/ZS-coated ATH					
Polyvinylchloride (PVC)	Aluminium hydroxide (ATH) Zinc borate Zinc-molybdenum compounds (together with phosphate esters) Zinc hydroxystannate (ZHS), Zinc stannate (ZS) & ZHS/ZS-coated ATH	Tricresyl phosphate (also plasticizer)	Tris (dichloropropyl) phosphate Vinylbromide	Rigid PVC is flame inherent itself	Cable sheets	Wire end cables, floor mats, industrial sheets.

Materials/polymers/resins	Inorganic alternatives to PentaBDE	Phosphorus/nitrogen organic alternatives to PentaBDE	Halogen organic alternatives to PentaBDE	Alternative flame retardant materials	Applications	Commercial commodities for the applications
Polyurethane (PUR)	Ammonium poly phosphate Red phosphorus	Melamine (nitrogen based) Dimethyl propyl phosphonate (DMPP) Reofos (non-halogen flame retardant)	Bromoalkyl phosphates Tetrabromophtalic anhydride Tris(chloroethyl) phosphate (TCPP) (together with brominated polyols or red phosphorus)	Intumescent systems	Cushioning materials, packaging, padding	Furniture, sound insulation packaging, padding panels, wood imitations, transportation.

Materials/polymers /resins	Inorganic alternatives to PentaBDE	Phosphorus/ nitrogen organic alternatives to PentaBDE	Halogen organic alternatives to PentaBDE	Alternative flame retardant materials	Applications	Commercial commodities for the applications
Unsaturated (Thermoset) polyesters (UPE)	Ammonium polyphosphate Aluminium hydroxide (ATH) Magnesium hydroxide Zinc hydroxystannate (ZHS), Zinc stannate (ZS) & ZHS/ZS-coated ATH	Triethyl Phosphate Dimethyl propyl phosphonate (DMPP)	Dibromostyrene Tetrabromophtalic anhydride based diol, Tetrabromophtalic anhydride Bis (tribromophenoxy) ethane	Intumescent systems	Circuit boards, coatings	Electrical equipment, coatings coatings for chemical processing plants mouldings, military and marine applications: construction panels.
Rubber	N/A	Alkyl diaryl phosphates (nitril rubber)	N/A	Intumescent systems	Transportatio n	Conveyor belts, foamed pipes for insulation.
Paints/lacquers	N/A	Triaryl phosphates (unspecified)	Tetrabromo phthalate diol Tetrabromophtalic anhydride based diol Bis (tribromophenoxy)	Intumescent systems Silicone rubber	Coatings	Marine and industry lacquers for protection of containers

			Ethane			
Textiles	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)	Trichloropropyl phosphate	Intumescent systems Aramide fibres (certain protective applications) Wool Modacrylic	Coatings	Back coatings and impregnation for carpets, automotive seating, furniture in homes and public buildings, aircraft, underground.

Materials/polymers/resins	Inorganic alternatives to PentaBDE	Phosphorus/ nitrogen organic alternatives to PentaBDE	Halogen organic alternatives to PentaBDE	Alternative flame retardant materials	Applications	Commercial commodities for the applications
Textiles cont.	N/A	Dimethyl hydrogen phosphite (DMHP) Melamine (nitrogen based) Phospho nitrilic chloride (PNC)	N/A	N/A	N/A	N/A
Hydraulic oils	N/A	Butylated triphenyl phosphate esters	N/A	N/A	Drilling oils, hydraulic fluids	Off shore, coal mining

N/A: not available or not applicable

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