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Report of the Persistent Organic Pollutants Review Committee on the work of its fourth meeting

Addendum

Risk management evaluation for commercial octabromodiphenyl ether

At its fourth meeting, the Persistent Organic Pollutants Review Committee adopted the risk management evaluation for commercial octabromodiphenyl ether, on the basis of the draft contained in document UNEP/POPS/POPRC.4/6, as amended. The text of the risk management evaluation is set out below. It has not been formally edited.

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COMMERCIAL OCTABROMODIPHENYL ETHER

RISK MANAGEMENT EVALUATION

Prepared by the ad hoc working group on
commercial octabromodiphenyl ether
under the Persistent Organic Pollutants Review Committee
of the Stockholm Convention

October 2008

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Executive Summary

The term "c-OctaBDE" designates a commercial mixture containing polybrominated diphenyl ethers, typically consisting of penta- to deca-bromodiphenyl ether congeners. c-OctaBDE has been used as an additive flame retardant mainly in the plastics industry for polymers used for housings of equipment containing electronics. The estimated annual world-wide production of c-OctaBDE in 1994 was 6,000 tonnes which decreased to 3,800 tonnes by 2001. Globally 70% of c-OctaBDE has been used in acrylonitrilebutadiene styrene (ABS). Other minor uses include high impact polystyrene (HIPS), polybutylene terephthalate (PBT) and polyamide polymers.

Production was phased out in the EU, Norway, Switzerland, Canada and the USA in the early to mid 2000's. In Japan, c-OctaBDE has never been produced; its import and sales were voluntarily phased out by 2005. There is no information available that indicates whether it is still being produced in developing countries. It has been reported that it is essentially impossible to buy c-OctaBDE at present, at the global level. Therefore, releases from production, handling and processing in these countries or regions should have already ceased or they are probably close to zero. Releases from use, disposal and recycling of products are due to volatile and particulate losses. The volatile loss over a ten year lifetime of a product containing c-OctaBDE was estimated to be 0.54% of its c-OctaBDE content. The corresponding estimate for particulate loss is 2%. These releases enter industrial or urban soil and dust (~75%), air (~0.1%) and surface water (~24.9%). Releases during the service life of products, particularly at their disposal contribute the most significant share to the total releases. Releases after disposal may be considered to be low. However, possible long-term increases in levels resulting from releases at waste sites might need to be considered further.

In light of the ban and phase-out of c-OctaBDE, the availability of practicable and economically viable substitutes for all its uses has already been demonstrated in practice. The potentially milder human health or environmental impacts of these alternatives have rendered them preferable over c-OctaBDE.

Levels of certain components of c-OctaBDE are detected in the environment. These have toxic properties and have been shown to be persistent and bioaccumulative. They thus represent a potential risk for future generations. Those findings have resulted in voluntary and regulatory phase-outs of c-OctaBDE in several regions of the world. Since this is a global, transboundary problem, global actions to phase out c-OctaBDE and include it in Annex A of the Stockholm Convention on Persistent Organic Pollutants should be considered.

Several countries have reported that they would have problems regulating a commercial mixture of OctaBDE. Listing the polybrominated diphenylethers (PBDE) congeners having POP characteristics would be consistent with existing national legislations and would facilitate the national monitoring and control of emissions, production and use.

Conclusion and recommendation

Having evaluated the risk profile for c-OctaBDE, and having concluded that components of this mixture are likely, due to the characteristics of its components, as a result of long-range environmental transport, to lead to significant adverse effects on human health and the environment, this risk management evaluation has been prepared, as specified in Annex F of the Convention.

The Stockholm Convention, through the Persistent Organic Pollutants Review Committee aims at protecting human health and the environment from POPs, while being mindful of the Precautionary Approach as set forth in Principle 15 of the Rio Declaration on Environment and Development. It seeks to adopt measures to eliminate releases from intentional POP production and use, to reduce or eliminate releases from unintentional POP production, and to reduce or eliminate POP releases from its stockpiles and wastes in an appropriate, environmentally sound manner.

Therefore, in accordance with paragraph 9 of Article 8 of the Convention the Committee recommends to the Conference of the Parties to consider listing and specifying the related control measures of hexa- and hepta-, bromodiphenyl ether congeners in Annex A of the Convention, as described above and using as markers for enforcement purposes: BDE153/154 (hexaBDE) and BDE175/183 (heptaBDE);

1. Introduction

1.1 Chemical identity of the proposed substance

Background
The European Union and its Member States, which are Parties to the Stockholm Convention, submitted a proposal in July 2006 for listing commercial octabromodiphenyl ether (c-OctaBDE) in Annex A of the Stockholm Convention.

Chemical identity of the proposed substance
The term "c-OctaBDE" designates a commercial mixture containing polybrominated diphenyl ethers (PBDEs) with varying degrees of bromination, typically consisting of penta- to deca-bromodiphenyl ether isomers and containing approximately 79% (by weight) organically bound bromine. This bromine content corresponds to a true OctaBDE

molecule and so the commercial products were often called “OctaBDE” even though the product contained a range of PBDEs.

These synthetic brominated compounds have been used mainly as flame retardants principally in the plastics industry for flame-retarded polymer products, typically the housings of office and other equipment containing electronics. According to the required flame retardancy, the finished products contain typically 5 to 30% c-OctaBDE by weight. The main use of c-OctaBDE is in ABS polymers with 12 to 18% weight loadings. Minor uses concern HIPS, PBT and polyamide polymers, at typical loadings of 12 to 15% weight in the final product.

PBDEs are flame retardants of the additive type, i.e. they are physically combined with the material being treated. This means that the flame retardant can diffuse out, to some extent, of the treated material and it is assumed that the total emission of c-OctaBDE to the environment is dominated by volatile losses from polymers over their service life.

Because of the chemical and toxic properties of its components, in particular isomers of hexabromodiphenyl ether (HexaBDE) and heptabromodiphenyl ether (HeptaBDE), and their wide spread occurrence in the environment and in humans c-OctaBDE causes concern in many regions in the world.

There are several components in the commercial product and so any assessment of the commercial product needs to include an assessment of the individual components. The commercially supplied OctaBDE (CAS Number: 32536-52-0) is a complex mixture. Table 1 shows typical composition of c-OctaBDE flame retardants (UK, 2007). The congener composition of widely-used commercial octaBDE mixtures, DE-79 and Bromkal 79-8DE was recently determined (LaGuardia *et al*., 2006). DE-79 was found to contain 15 PBDE congeners with major constituents including HexaBDE (BDE153, 8.7%), HeptaBDE (BDE175/183, 42%), OctaBDE (BDE197, 22%; BDE196, 10.5%; BDE203, 4.4%), and NonaBDE (BDE207, 11.5%). The DE-79 commercial octaBDE mixture has also been found to contain polybrominated dibenzofurans (Hanari *et al*., 2006). Bromkal 79-8DE contained 13 PBDE congeners with major constituents including HeptaBDE (BDE175/183, 13%), OctaBDE (BDE197, 10.5%; BDE196, 3.1%; BDE203, 8.1%), NonaBDE (BDE206, 7.7%, BDE207, 11.2%), and surprisingly DecaBDE in large quantities (BDE209, 50%).

Table 1: Typical composition of c-OctaBDE flame retardants (% by weight)

Main components	Up to 1994[a]	1997[c]	2000[d]	2001[e]	2006[f]	2006[g]
PentaBDE	10.5-12.0[b]		1.4-12.0[b]	≤0.5		
HexaBDE		5.5		≤12	10.5	0.3
HeptaBDE	43.7-44.5	42.3	43.0-58.0	≤45	45.5	12.8
OctaBDE	31.3-35.3	36.1	26.0-35.0	≤33	37.9	21.8
NonaBDE	9.5-11.3	13.9	8.0-14.0	≤10	13.1	18.9
DecaBDE	0-0.7	2.1	0-3.0	≤0.7	1.3	49.6

Note: a) 1994 data are taken from WHO (1994).
b) This value is for the total amount of PentaBDE + HexaBDE.
c) 1997 data are from a composite sample from three suppliers to the EU (Stenzel and Nixon, 1997).
d) 2000 data are taken from RPA (2001) and represent the composition reported to the OECD under a Voluntary Industry Commitment.
e) 2001 data from the Great Lakes Chemical Corporation represent the upper bound composition based on random sampling of selected production lots from August 2000 to August 2001.
f) Data for DE-79 manufactured by Great Lakes Chemical Corporation, USA (LaGuardia *et al*., 2006).
g) Data for Bromkal 79-8DE manufactured by Chemische Fabrik Kalk, Germany (LaGuardia *et al*., 2006).

1.2 Conclusions of the Review Committee regarding Annex E information

Annex E of the Stockholm Convention requires a Risk Profile to be developed to evaluate whether the chemical is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and/or environmental effects, such that global action is warranted.

A Risk Profile for c-OctaBDE was developed and accepted in 2007 (UNEP, 2007b). In decision POPRC-3/6, the POP Review Committee concluded as follows (UNEP, 2007a):
“*Taking into account the high potential of the components of commercial octabromodiphenyl ether to persist in the environment, to bioaccumulate and biomagnify and to represent a hazard for humans and wildlife at very low levels, The Persistent Organic Pollutants Review Committee:*

- Invites the intersessional working group on commercial octabromodiphenyl ether which prepared the risk profile to explore any further information on including octabromodiphenyl ether and nonabromodiphenyl ether related to risk estimations and bioaccumulation, including the environmental and health relevance of

de-bromination, and, if appropriate, to revise the risk profile for consideration by the Committee at its fourth meeting.

- Decides, in accordance with paragraph 7 (a) of Article 8 of the Convention, that the hexa- and hepta bromodiphenyl ether components of the commercial octabromodiphenyl ether are likely, as a result of long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted;

- Decides, in accordance with paragraph 7 (a) of Article 8 of the Convention, and taking into account that a lack of full scientific certainty should not prevent a proposal to list a chemical in the annexes of the Convention from proceeding, that the octa- and nona bromodiphenyl ether components of the commercial octabromodiphenyl ether are likely, as a result of long-range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted."

1.3 Data sources

Most developed countries have taken some actions to limit the production and use of c-OctaBDE. Until 2004, production occurred in the Netherlands, France, USA, UK and Israel (UNEP 2008, BSEF 2006) but c-OctaBDE is no longer produced in the EU and USA. Information about production in developing countries is sparse e.g. there is no production or uses in Armenia (UNEP 2008, Armenia). In addition, a number of international measures have also been taken related to c-OctaBDE.

European Union
Within the European Union, two producers of c-OctaBDE are reported in the EU IUCLID database in 1994. However, both companies stopped production within the EU (1996/1998).

The amount imported into the EU in 1999 was estimated to be 450 tonnes/year as the substance itself, with around 1,350 tonnes/year imported in finished articles (European Commission, 2003a). Due to legislative restrictions in place in the EU, import of c-OctaBDE as substance or in articles is prohibited, since "import" is considered as "placing on the market" in the EU legislation.

In the EU, c-OctaBDE was identified as a priority substance for risk assessment under Regulation 793/93/EEC. There are two areas where a definite need for risk reduction measures has been identified in the draft risk assessments for human health and the environment (subject to any further changes).

Based on the risk assessment, UK prepared a Risk Reduction Strategy and analysis of advantages and drawbacks of possible measures (RPA, 2002).

As a result of the European Union Risk Assessment process, Directive 2003/11/EC was adopted in 2003 (European Union, 2003) which prohibits the placing on the market and use of OctaBDE as a substance or as a constituent of substances or of preparations in concentration higher than 0.1% by mass. Articles may not be placed on the market if they, or flame-retarded parts thereof, contain OctaBDE in concentrations higher than 0.1% by mass. Member States were obliged to implement the prohibition by February 15, 2004 and apply the measures from August 15, 2004.

The European Union banned the use of PBDE in new electronics and electronic products as of July 1, 2006 pursuant to the Directive on restrictions on hazardous substances (RoHS) (European Union, 2002a).

To control and minimise environmental impacts from products containing PBDEs that are already in use, Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) sets specific requirements with respect to collection, recovery, permitting of treatment installations, treatment standards and separation (European Union, 2002b). The Directive obliges Member States to adopt appropriate measures to minimise disposal of products containing PBDEs as unsorted waste and to achieve a high level of separate collection of WEEE. Since August 13, 2005 collection systems from households and take-back obligations were required. By December 31, 2006, separate collection of at least four kilograms of WEEE per inhabitant per year from private households was to be achieved. Treatment is only allowed in authorised installations complying with minimum technical requirements. In addition minimum treatment requirements were specified and specific targets are set as recovery rates per appliance (by weight).

Brominated diphenylethers are mentioned as hazardous substances in the list of priority substances for water policy purposes, with the aim of progressively reducing pollution from these substances (European Union, 2000).

Prior to the Community level control measures on c-OctaBDE, several EU Member States had already introduced voluntary measures or national restrictions to phase out c-OctaBDE.

Switzerland
The Ordinance on Risk Reduction (ORR) related to the use of certain particularly dangerous substances, preparations and articles (Switzerland, 2005) severely restricts marketing and use of c-OctaBDE in Switzerland. It prohibits to place on the market and to use c-OctaBDE or substances and preparations with an c-OctaBDE content equal to or greater than 0.1% by mass, except for analysis and research purposes. It also prohibits introduction of new articles in the market if

they have parts that are treated with flame retardants containing c-OctaBDE exceeding 0.1% by mass. The prohibition in the ORRChem is the application of the EU Directive (European Union, 2003).

Norway
In Norway the use of c-OctaBDE is banned since July , 2004. From January 1, 2004, products containing more than 0.25 % c-OctaBDE are classified as hazardous waste if discarded (UNEP, 2007c Norway).

United States of America
In the USA c-OctaBDE is subject to EPA's Toxic Substances Control Act (TSCA) Inventory Update Reporting Rule, under which production and import information is periodically collected. For the 2002 reporting year, U.S. production of c-OctaBDE was estimated in the range of 450 to 4,500 tonnes, and none reported for the 2006 reporting year (UNEP 2007, USA).

A voluntary phase out of production of c-OctaBDE went into effect January 1, 2005, followed by TSCA Significant New Use Rule (US EPA, 2006) to require notification upon any restart of production or import, for any use.

Several American States have passed legislation restricting or banning c-OctaBDE in the USA:

The status of the chemical under American States legislation is listed in UNEP/POPS/POPRC.4/INF/10 .

Canada
c-Octa BDE has never been produced in Canada (UNECE survey 2007, Canada). Results from a recent survey conducted for year 2000 confirmed that c-OctaBDE is not manufactured in Canada. However, approximately 1300 tonnes of PBDEs (including c-OctaBDE) were imported into Canada in that year (UNEP, 2007c Canada).

Canada published a scientific screening assessment on PBDEs on July 1, 2006. This assessment indicates that PBDEs, including all BDE congeners contained in c-OctaBDE, are toxic under section 64(a) of the Canadian *Environmental Protection Act*, *1999* (CEPA 1999). The report also recommends the implementation of virtual elimination for tetra-, penta- and hexaBDEs which were found to be persistent, bioaccumulative, and present in the environment primarily due to human activity. PBDEs were added to Schedule 1 (List of Toxic Substances) of CEPA 1999 in December 2006 (Canada Gazette, 2006b). In Fall 2006, Canada publicly released a proposed risk management strategy for addressing the identified risks posed by the use and/or release of PBDEs.

On July 9, 2008, Canada published the final *Polybrominated Diphenyl Ethers Regulations*. These Regulations prohibit the manufacture of seven PBDEs (tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE, nonaBDE and decaBDE) in Canada. The Regulations also prohibit the use, sale, offer for sale and import of tetraBDE, pentaBDE, hexaBDE and mixtures, polymers and resins containing these substances, and prohibit the manufacture of these mixtures, polymers and resins.

In addition to the *Polybrominated Diphenyl Ethers Regulations*, Canada is working on several other risk management actions, including: (i) a regulation to control PBDEs in domestic and imported manufactured products; (ii) a Performance Agreement with industry to minimize releases to the environment from the use of the DecaBDE commercial mixture in Canadian manufacturing operations; (iii) a detailed review of newly published science on the bioaccumulation and environmental transformation of decaBDE in order to determine whether further controls on this form of PBDE are warranted; (iv) development of a management strategy for PBDE-containing products at end-of-life, and; (v) monitoring Canadians' exposure to PBDEs.

Asia-Pacific
c-OctaBDE has never been produced in Japan; it was imported. However, import and stock sales were voluntarily phased out by 2005.

c-OctaBDE was removed from the Australian Inventory of Chemical Substances (AICS) in February 2007.

By February 2006, China promulgated a law similar to the EU RoHS Directive. Targeted substances are the same as those targeted in the EU RoHS. When fully implemented, it will prohibit c-PentaBDE and c-OctaBDE use in new electric and electronic equipment. Implementation of phase 1 of the law (marking and disclosure only) came into effect March 1, 2007; implementation schedule for Phase 2 (full restriction) is currently unclear.

1.4 Status of the chemical under international conventions

The UNECE Convention on Long-range Transboundary Air Pollution
In 2005, c-OctaBDE was nominated as a new POP to the Convention and considered by the Executive Body of the Convention to meet the screening criteria for POPs. In 2006, management options for c-OctaBDE were assessed to give a basis for later negotiations on restrictions.

OSPAR Commission[1]
Brominated flame retardants were given priority in the 1992 OSPAR Action Plan and were included in the OSPAR List of Chemicals for Priority Action in 1998. c-Octa-BDE is part of the list of substances of possible concern (OSPAR, 2004). There are no specific OSPAR measures targeting releases of brominated flame retardants. OSPAR has promoted activities in the EC on use restrictions for PBDEs, risk-reduction strategies for octaBDE, decaBDE and HCBD and waste legislation. Environmental monitoring data indicate that discharges/releases of pentaBDE and octaBDE are decreasing. However, some diffuse releases may remain due to illegal occurrence in imported products (plastics etc.) (OSPAR, 2008).

Helsinki Commission (HELCOM)
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.

1.5 Any national or regional control actions taken

OECD (Organisation for Economic Cooperation and Development)[2]
Following the 1994 publication of a risk management monograph on brominated flame retardants--substances added to synthetic fibers and plastics to prevent fires and smoke--OECD Member countries and the manufacturers of these substances held discussions on possible actions that could further reduce risks. 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. (Overview of VIC, US/European VIC, Japan VIC) Compliance with the VIC is on-going. In parallel to this work, OECD conducted an investigation of the waste management practices in Member countries with respect to products containing Brominated Flame Retardants. The results of this investigation are documented in the Report on the Incineration of Products Containing Brominated Flame Retardants. In 2004 the first Hazard/Risk Information Sheets for five Brominated Flame Retardants were posted on the OECD site. The Information Sheets were updated in 2005[3].

2. Summary information relevant to the risk management evaluation

2.1 Identification of possible control measures

There are in principle several control measures that could be implemented to reduce the use of c-OctaBDE and/or to reduce the environmental impacts associated with the use of this substance, but some of these go beyond the scope of the Stockholm Convention. These include voluntary commitments by industry, eco-labelling schemes, economic instruments and a deposit refund system.

A ban/restriction on the production and use of c-OctaBDE and/or the components of the commercial mixture would be an effective measure if properly enforced. Some countries have already taken such actions. Standards aimed at reducing the concentrations of PBDEs in products would be very effective (RPA, 2001). However, the possibility that a reduction of concentrations of PBDEs could lead to lack of effectiveness may limit the scope of this strategy. Standards could be used to ensure environmentally benign waste handling. Risk management would be best achieved by a global ban on production and use of c-OctaBDE, brought about by listing the components of the mixture under the Stockholm Convention. Suitable, more environmentally benign alternatives exist for all uses of c-OctaBDE so a ban could cover all sectors. A ban would eliminate emissions from the manufacturing of c-OctaBDE, and also eliminate release of bromodiphenyl ethers from the production and use of c-OctaBDE in new products. An important consideration is that a simple ban would not affect the emissions from c-OctaBDE in products already in use.

A ban on the production and use of c-OctaBDE would also affect waste issues. Listing a substance under the Stockholm Convention implies a ban on recycling and reuse of stockpiles and to treat contaminated sites. Article 6 of the Convention requires that wastes and stockpiles are handled in a safe, efficient and environmentally sound manner, so that the content is destroyed or irreversibly transformed. The article also bans disposal operations that lead to recovery, recycling, reclamation, direct use or alternative use of the POPs material.

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[1] The 1992 OSPAR Convention is the current instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. It combined and up-dated the 1972 Oslo Convention on dumping waste at sea and the 1974 Paris Convention on land-based sources of marine pollution.

[2] http://www.oecd.org/document/63/0,3343,en_2649_34375_2403647_1_1_1_1,00.html

[3] http://www.oecd.org/dataoecd/44/46/36423809.pdf

Various control measures at the production or waste handling facilities would ensure safe work environments and regulations on waste handling of products etc. These measures could be applied at waste handling facilities. If properly designed and enforced this could be an effective tool to reduce releases from the sources in question.

2.2 Efficacy and efficiency of possible control measures in meeting risk reduction goals

The choice of control measure for the remaining use and production of c-OctaBDE must take into account that most developed countries have phased out production of c-OctaBDE. However, action is still needed for the protection of human health and the environment from emissions and releases of the components of c-OctaBDE. Further risk reduction options should be examined against the following criteria (RPA, 2001):

- *Effectiveness*: the measure must be targeted at the significant hazardous effects and routes of exposure identified by the risk assessment. The measure must be capable of reducing the risks that need to be limited within and over a reasonable period of time.

- *Practicality*: the measure should be implementable, enforceable and as simple as possible to manage. Priority should be given to commonly used measures that could be carried out within the existing infrastructure.

- *Economic impact*: the impact of the measure on producers, processors, users and other parties should be as low as possible.

- *Monitorability*: monitoring should be possible to allow the success of risk reduction to be assessed.

2.2.1 Waste handling

A ban on production and use of c-OctaBDE would not in itself affect emissions of its components of concern from waste handling, where they can present a technical and legacy problem. However, listing a substance under the Stockholm Convention implies a ban on recycling and reuse of stockpiles of c-OctaBDE itself. Article 6 in the Convention requires that wastes and stockpiles are handled in a safe, efficient and environmentally sound manner, so that the content is destroyed or irreversibly transformed, taking into account international rules, standards and guidelines. The article also bans disposal operations that lead to recovery, recycling, reclamation, direct use or alternative use of POPs material.

A special challenge could be to separate c-OctaBDE containing articles from those without the substance, since most articles are not labelled telling what they contain. However, there is information about articles that have contained c-OctaBDE in the past and about which articles it is used in today, like electronic articles, textiles and isolation material and casing materials. National authorities would have to conduct surveys to get more detailed information about c-OctaBDE 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.

Targets for phase out of the use of existing products containing c-OctaBDE and the collection of these could be considered according to Annex A or B of the Convention. Since there are substantial stocks of products containing c-OctaBDE in use, national authorities could consider some additional measures to limit releases. These measures could range from establishing collection points where people can deliver their used products to more actively promoting and encouraging people to deliver their waste products. A deposit-refund system does not seem appropriate since sales of new products containing c-OctaBDE would no longer be allowed and their presence has become a legacy problem. However, paying people a fee to deliver their products would be an option, although a source of funding for such an operation is not obvious.

A special challenge would be to ensure proper handling of c-OctaBDE-containing waste material/articles in developing countries. Since these countries have limited experience in handling this kind of waste, they would need practical help and information as well as financial help to ensure environmentally sound handling of this waste. The assistance could include how to dismantle c-OctaBDE-containing articles, treat the various parts and the methods of environmentally sound treatment of the final c-OctaBDE. If listed under the Stockholm Convention, guidelines on sound waste treatment of c-OctaBDE and articles containing c-OctaBDE will be developed under the Basel Convention (Article 6 para 2 of the Stockholm Convention).

2.2.2 Measures to reduce emissions

The UNECE survey 2007 indicated the lack of information on emission control techniques which are already applied or which may be applied in the near future, such as alternative production processes and technologies, alternative operating practices and/or other pollution prevention techniques to reduce the release of c-OctaBDE to the environment. No specific studies on c-OctaBDE emission control techniques have been identified.

The main remaining releases of c-OctaBDE occur during the service life and particularly at disposal of products containing c-OctaBDE. Controlling emissions caused by volatile losses from polymers over their service life is very difficult. The use of reactive type flame retarding compounds could be recommended as one potential measure.

Concerning emission control at disposal, several measures can be taken to reduce possible emissions. They are briefly discussed in this section.

A ban would eliminate emissions from the production, manufacturing and use of c-OctaBDE in new products. It would not affect the emissions from products already in use. Additional regulations could therefore be considered. This would for example be relevant for recycling and dismantling of electronic articles containing c-OctaBDE. Within the EU specific requirements concerning collection, recovery, permitting of treatment installations, treatment standards and separation are already established for plastics containing PBDEs (European Union, 2002).

Specific measures concerning the handling of waste at disposal and recycling/recovery could include separating articles containing c-OctaBDE from those without the substance (it is problematic to identify such articles) and sending them to controlled disposal processes (e.g. treatment as hazardous waste) or setting targets for the phase out of the use of existing products containing c-OctaBDE and implementing collection of these products. XRF guns are portable and can detect Bromine in articles with an automatic readout to indicate a pass or fail for ROHS or other regulatory standards. US federal agencies use this technology routinely. For example see http://www.innovxsys.com/en/products/eb/defender.

There are also concerns over export of electronic waste to developing countries leading to c-OctaBDE releases during recycling operations. In addition, burning or incineration of c-OctaBDE-containing waste could lead to formation and release of brominated dibenzo-*p*-dioxins and furans (Leisewitz *et al*., 2000).

During the use of c-OctaBDE, there are a number of measures that plastics compounders and processors could take to reduce their environmental emissions of c-OctaBDE. For example, in relation to losses to waste water and air via settling out of dust and subsequent release through washing, companies could modify their practices such that the dust is collected and disposed of as controlled waste. In relation to volatile losses, companies could ensure that all processes are totally closed, preventing losses to the environment, or they could install abatement technology at the site to ensure that any potential emissions are captured (RPA 2002).

In general measures identified to reduce environmental emissions at compounders and processors could also be applied to disposal, recycling/recovery and facility-dismantling. These should aim at minimising dust and air emissions and at avoiding input to waste water. In particular, measures could be suggested to reduce releases at disposal by applying BAT/BEP (Best Available Techniques/Best Environmental Practice) at disposal and recycling/dismantling/reuse. A source for possible measures is the BREF[4] on waste treatment, despite specific measures for recycling/recovery and dismantling have not been identified in it (European Commission, 2006). Other possible measures include simple technical and organisational measures and end-of-pipe controls to reduce releases to the environment, such as:

- considering generic techniques applied to waste storage (e.g. controlled run-off from storage places; using polymer sheeting to cover open solids storage facilities that may generate particulates);
- considering techniques to reduce water use and prevent water contamination (e.g. by vacuuming and dust collection in preference to hosing down);
- minimising dust input to waste water and dust collection and disposal as controlled waste (incineration or landfill);
- applying appropriate waste water treatment processes;
- using local exhaust ventilation to control dust and volatile emissions;
- shredding in closed systems, including dust separation and thermal treatment of exhaust air.

2.3 Information on alternatives (products and processes) where relevant

The phase out of c-OctaBDE is already advanced: production has stopped in the EU, USA and Canada. Voluntary phase out by industry is underway in Japan. In light of the ban and phase out of c-OctaBDE in 2004 in the European Union and an already increasing use of alternatives, the availability of practicable and economically viable substitutes has already been demonstrated in practice (see INF document related to this paper).

[4] BREF = Best available techniques REFerence document

Design changes can eliminate the need for flame retardants by using alternative materials or designs that remove the need for chemical flame retardants (see INF document related to this paper).

2.3.1 Chemical substitutes for c-OctaBDE in ABS plastic

The report "Risk Reduction Strategy and Analysis of Advantages and Drawbacks for Octabromodiphenyl Ether" (RPA, 2002) preceding the EU level control measures contains an analysis on the suitability of various alternatives to c-OctaBDE in terms of technical performance, health and environmental risks and cost implications. Potential alternatives identified include tetrabromobisphenol-A, 1,2-bis(pentabromophenoxy) ethane, 1,2-bis(tribromophenoxy) ethane, triphenyl phosphate, resourcinol bis (diphenylphosphate) and brominated polystyrene.

In ABS, TBBPA and brominated epoxy oligomers are used as additive flame retardants meaning that they are not bound to the polymer and therefore 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 (Birnbaum and Staskal, 2004). 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 (RPA, 2002; OSPAR, 2005) . 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 (Morose, 2006).

Bisphosphate and its derivatives include RDP and are used in "Blue Angel" printers and PCs with PC / ABS casings (Leisewitz et al., 2000). The US EPA DfE report lists triaryl phosphate and an isopropylated derivative as having moderate bioaccumulation properties based on structure activity relationships (US EPA, 2005). Bis (tribromophenoxy) ethane is poorly characterized. Studies by its manufacturer indicate low toxicity, but the substance tends to persist and bioaccumulate (Washington State, 2005).

2.3.2 Chemical substitutes for c-OctaBDE in synthetic textiles

Reactive-type flame retardants are usually used in thermosetting material (e.g. polyester resins, epoxy resins, polyurethanes). Chemical substitutes for c-OctaBDE in textiles include reactive phosphorous constituents and hexabromocyclododecane. Specific reactive phosphorous constituents were not identified in a Danish report though polyglycol esters of methyl phosphonic acid (CAS 676-97-1) have been used for flame retardants in polyurethane foam (e.g. CAS 294675-51-7) (Danish Environmental Protection Agency, 1999). Methyl phosphonic acid has attracted attention of those working on chemical weapons since it is a degradation product of VX, sarin, and soman (OPCW, 2006). Researchers at the Oak Ridge National Laboratory in the US describe methyl phosphonic acid as one of degradation products of chemical weapons with "significant persistence"(Munro *et al*. 1999a), However, methyl phosphonic acid does not appear to be bioaccumulative (Munro *et al*. 1999b). Other types of reported toxicity are minimal, but the substance reacts violently with water (US EPA, 1985). The phosphonic acid family also includes amino-methyl phosphonic acid, a degradation product of the herbicide glyphosate (also known as [carboxymethylamino] methyl phosphonic acid.)

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 (Birnbaum and Staskal, 2004),

2.3.3 Chemical substitutes for c-OctaBDE in thermoplastic elastomers

Additive-type flame retardants are usually used in thermoplastic material (e.g. Polypropylen, Polyethylen, Ethylen-Vinylacetate, PVC).

Chemical substitutes for c-OctaBDE in thermoplastic elastomers include bis (tribromophenoxy) ethane and tribromophenyl allyl ether (Danish Environmental Protection Agency, 1999). Bis (tribromophenoxy) ethane is discussed above under alternatives for c-OctaBDE in ABS plastic. Very little information was available for tribromophenyl allyl ether, though it is on a list of flame retardants considered "deferred" for testing by the interagency testing committee of US EPA (IPCS, 1997).

2.3.4 Chemical substitutes for c-OctaBDE in polyolefins

Chemical substitutes for c-OctaBDE in polyolefins include polypropylene-dibromostyrene, dibromostyrene, and tetrabromobisphenol A (TBBPA) (Danish Environmental Protection Agency, 1999). TBBPA is described above in chemical substitute alternatives for c-OctaBDE in ABS plastic. 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 (Pakalin et al., 2007).

2.3.5 Technical feasibility

All above described alternatives to c-OctaBDE are technically feasible and have been used in commercial applications.

The EU RPA concludes, "Based on consultation with industry, it is evident that most companies have already replaced octabromodiphenyl ether in their products with other flame retardants and some companies utilise design measures, rather than flame retardants, for certain types of products. Overall, there does not appear to be any major technical obstacle to replacement of the substance, although some of the flame retardant/polymer combinations considered in this section may have inferior technical performance in certain applications" (RPA, 2002).

Many high profile companies have already implemented alternatives to c-OctaBDE. For example, Dell (#1 in US PC sales) eliminated all halogenated flame-retardants in all desktop, notebook and server chassis plastic parts in 2004 and has recently expanded these restrictions to include all products designed after June 2006 (Greiner et al., 2006). Lenovo (#6 in US PC sales) has eliminated PBDEs including c-OctaBDE in all of their products (Pierce, 2006). LG Electronics (#8 in US TV sales) plans to eliminate all brominated flame retardants by 2010 (Clean Production Action, 2006). A comparison of computer, TV, and game manufacturers on their BFR phase-out timelines and BFR-free products has also been assembled by Greenpeace and is updated every three months (Greenpeace International, 2007).

Additional companies that have phased out PBDEs in all their products include: IBM, Ericsson, Apple, Matsushita (including Panasonic), Intel, and B&O (Lassen et al., 2006).

2.4 Summary of information on impacts on society of implementing possible control measures

2.4.1 Benefits of phasing out c-OctaBDE

The most obvious benefit to global society of phasing out c-OctaBDE would be reduced risk to human health and the environment due to reduced releases to air, water and soil of the components considered to be POPs, as well as their releases in workplace settings (UNEP, 2007b). Some components of c-OctaBDE enter into the food chain and bioaccumulate in fatty tissues of top predators, including humans. They have been detected in several endangered species.

Levels of some c-OctaBDE components have been found in humans in all regions of the world (UNEP, 2007b). Potential exposure of humans is through food and use of products containing c-OctaBDE. c-OctaBDE transfers from mothers to embryos and breastfed infants. UNEP (UNEP, 2007b) concludes that c-OctaBDE is likely to cause significant adverse effects on human health or the environment, such that global action is warranted. Its continued use could entail a potentially large cost.

Fire prevention is important for protecting human safety, and avoiding social and economic losses due to fire, and also for preventing the spread of toxic materials released by fires into the environment. Using less quantity of flame retardant substances, or less effective retardant agents, could therefore cause greater losses if fires become more frequent. However, according to European Commission (European Commission, 2005), the available alternatives function as well as c-OctaBDE and most of them are less hazardous to the environment than c-OctaBDE.

An estimate should be made of cost reduction to society from reduced damage to ecosystems and public health, when materials like c-OctaBDE are removed from the market. The value of reduced damage to environment and health is difficult to quantify, but several methods have been suggested. The Polluter Pays Principle, under which such costs should be internalized by the producer and/or the user, is seldom applied (at least without regulatory assistance); so, no good estimates are available of the potential cost of damage avoided. Anyhow, overall net benefits of phasing out c-OctaBDE for human health and the environment are most likely positive.

2.4.2 Cost implications for industry

Production was recently phased out in the EU, Norway, Switzerland, Canada, Japan and the USA. No information has been found indicating whether it is being produced in developing countries. Processing of c-OctaBDE is considered nonexistent in the EU and Canada. Appropriate substitutes for c-OctaBDE are available and mass-production of alternatives can significantly lower their costs (Ackerman and Massey , 2006).

Canada expects null cost impacts on industry due to substitution of c-OctaBDE (Canada Gazette, 2006a). Because of the complete ban and phase out of c-OctaBDE a similar conclusion can be made for Europe. Taking account of the voluntary phase out of c-OctaBDE in the USA, additional costs are also not expected for USA industries.

Canada considers that it is not possible to quantify and monetise the preventative (health and environment) benefits of the proposed regulations because PBDE use by industry has been discontinued and future demand for this substance cannot be estimated. However, costs to industry and government of the proposed regulations have been estimated considering the economic criterion of cost to industry due to reformulating away from c-OctaBDE. This cost was deemed to be nil (zero) as substitutes are available, their price dropped, and c-OctaBDE is no longer being manufactured, imported or used in Canada. Therefore, the industry is not expected to experience any incremental costs as a result of the regulatory requirements. Costs to government were also considered as part of the economic analysis, which included compliance promotion and enforcement activities; these costs were calculated over a 25-year time frame and estimated to be in the order of $439,646 (discounted at 5.5%). Overall, the Regulations were estimated to result in a negative net benefit of $439,646 (net present value discounted at 5.5%) over a 25-year time frame (UNEP, 2008 Canada).

Also if a ban of c-OctaBDE comes into force it would be reasonable to implement BAT/BEP (Best Available Techniques/Best Environmental Practices) in order to reduce releases from products containing c-OctaBDE at disposal and recycling/recovery facilities. Additional costs could particularly arise from technical measures applied at disposal, recycling/recovery and dismantling facilities. Possible technical measures are related to BAT/BEP and require economically reasonable operational and/or investment costs. By definition, costs due to the application of BAT are economically viable, as this term designates economically and technically available techniques. The BEPs are usually linked to BAT and its effective and efficient operation.

Installing end-of-pipe control technologies could be costly, but in most countries, particularly in developed ones, end-of-pipe measures already exist for disposal and recycling/reclamation plants (e.g. for off-gas cleaning in incineration plants and emission control in shredding plants). Therefore, expected cost implications are limited to those countries.

Within the EU, the European Commission and the UK have prepared a Risk Reduction Strategy and an analysis of advantages and drawbacks of possible measures to reduce the risks identified for the environment through the European Union Risk Assessment procedure (RPA, 2002). In light of the ban and phase out of c-OctaBDE such analysis is no longer up-to-date, in particular regarding the economic assessment.

2.4.3 Cost implications for consumers

In the RPA cost assessment it has been indicated that increased costs would be passed on to the consumer (RPA, 2002). As there will be no further increases in cost to industry, no increased cost for consumers are expected. However, even though c-OctaBDE may no longer be used in production of consumer items, there will be a considerable bank of products in the community which do contain c-OctaBDE. There will clearly be costs to consumers if jurisdictions pass on them the costs of environmentally sound disposal (ESD) methods.

2.4.4 Cost implications for state budgets

In the EU no incremental costs for state budgets are expected due to the ban and phase out of c-OctaBDE as a consequence of the proposed option. Additional budgets for enforcement and compliance are not required.

Canada has performed a regulatory impact analysis for the costs incurred by the federal government as a result of enforcement and compliance promotion activities related to the *Polybrominated Diphenyl Ethers Regulations*. Published on July 9, 2008 (prohibition of the manufacturing of seven PBDEs (tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE, nonaBDE and decaBDE); prohibition of the use, sale, offer for sale and import of tetraBDE, pentaBDE, hexaBDE and mixtures, polymers and resins containing these substances, and prohibition of the manufacture of these mixtures, polymers and resins)

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Key assumptions used for the analysis include the following:

- Time frame for analysis: costs and benefits are assessed over a 25-year time frame (2007 to 2032).
- Accounting stance: the costs and benefits assessed are those that directly or indirectly affect Canada or Canadians. All costs and benefits are in 2006 Canadian dollars[5].
- Discount rate: where possible, impacts are reported as net present values and a real social discount rate of 5.5% is used.
- Risk and uncertainty testing: the key sources of uncertainty were identified and are considered in the analysis.

Total enforcement and compliance promotion costs for the Canadian Government over the 25-year time frame were reported to be in the order of $327,420 Canadian dollars which can be split up as follows:

- With respect to enforcement costs, for the first year following the enforcement of the Regulations, a one-time amount of $75,000 will be required for the training of enforcement officers.

[5] 1€ = 1.53 Canadian dollars

- In addition, for years one through five following the delivery of the training, the enforcement costs are estimated to require an annual budget of $22,633 broken down as follows: $7,475 for inspections (which includes operations and maintenance costs, transportation and sampling costs), $14,330 for investigations and $828 for measures to deal with alleged violations (including environmental protection compliance orders and injunctions).

- For the subsequent years (6 through 25), the enforcement costs are estimated to require a total budget of $47,582 broken down as follows: $13,500 for inspections (which includes operations and maintenance costs, transportation and sampling costs), $14,330 for investigations and injunctions, $1,656 for measures to deal with alleged violations and $18,096 for prosecutions.

- Compliance promotion activities are intended to encourage the regulated community to achieve compliance with the Regulations. Compliance promotion costs would require an annual budget of $118,000 during the first year of coming into force of the Regulations. Compliance promotion activities could include mailing out of the final Regulations, developing and distributing promotional materials (i.e. a fact sheet, Web material), the development of an advertising campaign in specialized trade publications, attendance at association conferences and workshops/information sessions to explain the Regulations. This could also include responding to and tracking inquiries in addition to contributing to the compliance promotion database.

- In the four years that follow, compliance promotion activities could decrease in intensity and focus on sending letters, advertising in specialized trade magazines, attending association conferences, responding to and tracking inquiries, and contributing to the compliance promotion database. This would require a budget of $36,800. Note that a higher level of effort for compliance promotion may be required if enforcement activities of the Regulations are insufficient. For subsequent years, no additional compliance promotion activity is expected, and therefore, total compliance promotion costs are estimated at $154,800.

To conclude, Canada expected no incremental costs for state budgets in light of the regulations on PBDE. Additional budgets for enforcement and compliance are not required.

No information has been provided by developing countries concerning the impact of the possible restriction of c-octaBDE. However, as some of these countries use or have used this substance, its listing to the Convention could have some incremental costs on their state budgets. In this regard, it may be necessary to ensure technical and financial assistance for these countries to allow them to respect their obligations under the Stockholm Convention.

2.4.5 Comparisons of costs and benefits

Given the conclusions of the Risk Profile (UNEP 2007) for C-OctaBDE, its widespread global occurrence in biota and in humans, action taken or underway to phase it out in developed and developing countries and the increased demand for alternatives to C-OctaBDE, the overall consequence of a full global phase-out is most likely to be positive. Overall, the cost for developed countries of a phase out of C-OctaBDE should be small, as discussed above. However, specialized waste management and disposal related to C-OctaBDE (stockpiles and articles) could be costly for some countries and financial and technical assistance to developing countries should be considered to address this aspect as required.

2.5 Other considerations

2.5.1 Possible management options

The objective of the Stockholm Convention is to protect human health and the environment from POPs while being mindful of the Precautionary Approach as set forth in Principle 15 of the Rio Declaration on Environment and Development. In practice this means adopting measures to eliminate releases from intentional production and use such as prohibition of production, use, import, and export; setting measures to reduce the releases from unintentionally-produced POPs with the goal of continuing minimization and ultimate elimination; and devising measures to manage stockpiles and wastes in an appropriate environmentally sound manner.

The main remaining emissions of c-OctaBDE occur during the service life and particularly at disposal and recycling/reclamation of products containing c-OctaBDE; however, re-introduction of a product or similar products is currently possible.

Possible management options are to restrict or eliminate production and use of c-OctaBDE and/or its congeners having POP characteristics. Listing c-OctaBDE but naming the individual congeners as markers for enforcement purposes could facilitate the monitoring and control of emissions, production and use. This would also be consistent with existing national legislations. All mixtures containing congeners having POP characteristics would then be covered by the Convention, except when they occur as traces.

Options for the regulation of c-OctaBDE have also been discussed in the risk management evaluation of c-PentaBDE (UNEP, 2007d). It was suggested that, if a decision is taken to list the bromodiphenyl ethers with four or five bromines, consideration should be given to also listing HexaBDE, which constitutes a small proportion of the c-PentaBDE mixture. While this has some obvious advantages, the earlier information on c-PentaBDE (including the Annex D Risk profile statement) has not included much information about the HexaBDE. Also, since HexaBDE is a component of the c-OctaBDE, listing the HexaBDE would need to be considered when evaluating management options for c-OctaBDE.

In agreement with a risk management evaluation for c-PentaBDE, the Persistent Organic Pollutants Review Committee decided, in accordance with paragraph 9 of Article 8 of the Convention, to recommend to the Conference of the Parties that it consider listing in Annex A of the Stockholm Convention 2,2', 4,4'- tetrabromodiphenyl ether (BDE-47, CAS No. 40088-47-9) and 2,2',4,4',5-pentabromodiphenyl ether (BDE-99, CAS No. 32534-81-9) and other tetra- and pentabromodiphenyl ethers present in commercial pentabromodiphenyl ether, using BDE-47 and BDE-99 as markers for enforcement purposes (UNEP 2007a).

2.5.2 Discussion of options

c-OctaBDE can be released from production, handling, compounding and conversion (processing), use of products, disposal, recycling and dismantling.

In order to achieve long term elimination and prevent re-introduction of c-OctaBDE or the congeners having POP characteristics, production and use should be completely banned. Only this action would ensure the long term elimination of all risks from the POP components contained in commercial BDE mixtures and would contribute to achieving maximum non-quantifiable benefits. This would also prevent new production of c-PBDE using different congeners of hexa- and heptaBDEs to formulate new c-PBDE mixtures.

Several countries have reported that they will experience problems to regulate a commercial mixture of PentaBDE (UNEP 2007d) because most national regulations concern compounds. This is also valid for c-OctaBDE. For this reason, POPRC has recommended listing tetra- and pentabromodiphenyl ethers using specific BDE congeners as markers for enforcement purposes. Likewise, for c-OctaBDE, hexa- and hepta-, bromodiphenyl ether congeners could be listed and the following relevant congeners could be used as markers for enforcement: BDE153/154 (hexaBDE) and BDE175/183 (heptaBDE). This has two advantages. First, the markers serve as precise regulatory indicators to support more efficient monitoring and control. Second, production and use of all components of the c-OctaBDE mixture will be prohibited in keeping with Convention objectives.

Based on the chemistry of the PBDE formation reactions, it is unlikely that it would be cost-effective for industry to produce mixtures excluding the major identified congeners using current manufacturing processes.

3. Synthesis of information

3.1 Summary of evaluation

The term "c-OctaBDE" designates a commercial mixture containing polybrominated diphenyl ethers, typically consisting of penta- to decabromodiphenyl ether congeners. The specific composition of older mixtures or mixtures from various countries may be different. c-OctaBDE has been used as an additive flame retardant mainly in the plastics industry for polymers used for housings of office equipment. The risks it poses to human health and the environment have been explored in the Annex E Risk profile adopted by the POPRC in November 2007 (UNEP, 2007b).

There are national and international standards for fire safety for some product groups. This applies for example to electrical material, industrial packaging, upholstered furniture, curtains, electronic household appliances and electrical cables. These standards specify the flame-retarding properties that are required. Traditionally brominated flame retardants have been considered to be the most cost-effective way of imparting ignition resistance to many types of articles. However, in many cases these are being replaced with flame retardants without bromine, or the design of the product is changed so that there is no need for the continued use of flame retardant chemicals.

Suitable and economically viable alternatives are available for all uses of c-OctaBDE. Their human health or environmental impacts render them preferable over c-OctaBDE. However, some alternatives currently in use cause concern because of their properties or lack of available data. Reactive-type flame retardants, where these can be used, and halogen-free substitutes appear to be generally preferable regarding environmental and health aspects.

Incremental costs as a result of a complete ban are not expected for the industry.

A ban of c-OctaBDE would ultimately eliminate emissions from the production, manufacturing and use in new products. It would neither affect the emissions from products already in use nor directly influence emissions from disposal or recovery. Application of BAT/BEP at disposal and recycling/dismantling/reuse could be an efficient and economically reasonable way to minimise related emissions.

Costs implications for consumers are not expected.

Financial costs for Governments would depend on the management actions taken. There might be costs associated with mandated control measures e.g. monitoring and enforcement of waste management facilities. There might also be costs associated with monitoring and controlling articles containing c-OctaBDE.

3.2 Elements of a risk management strategy

Since the dissemination of bromodiphenyl ethers into the environment is a global, transboundary problem, some global actions to phase out c-OctaBDE should be considered. Risk management could be best served by a global ban on production and use of c-OctaBDE covering all sectors. Listing congeners of c-OctaBDE having POP characteristics under Annex A of the Stockholm Convention would be the most appropriate measure, given that most developed countries have already banned production. Developed countries have in place all monitoring and control capacities as well as legislative tools to enforce a ban. Thus, the main enforcement challenge would be for the developing countries to get sufficient capacities in place.

Using relevant congeners of the c-OctaBDE mixture as markers for enforcement purposes would be consistent with existing national legislation in several countries for components of c-OctaBDE and would facilitate the national monitoring and control of emissions, production and use.

Providing guidance on criteria for the selection of alternatives to c-OctaBDE should be part of the risk management strategy for the elimination of this substance. It will be important to discourage the replacement of c-OctaBDE with other environmentally harmful substances.

Waste fractions containing c-OctaBDE should be handled in a safe, efficient and environmentally sound manner. A cost effective way to identify such wastes is needed. This could impose extra costs on some countries and sectors. The solutions for waste handling should, to a large extent, depend on local conditions and be designed to fit into existing systems and traditions, taking the broad rules of the Stockholm Convention into consideration, including the general guideline on waste handling in the Basel Convention, which includes in its Annex VIII such substances as PCBs, polybromobiphenyls and 'other polybrominated analogues'.

4. Concluding statement

This risk management statement has been prepared in accordance with the content specified in Annex F of the Convention, and builds on the Risk Profile adopted by the POPRC in November 2007 (UNEP, 2007b). It concludes that components of commercial octabromodiphenyl ether are likely, as a result of long range environmental transport, to lead to significant adverse human health and/or environmental effects such that global action is warranted.

The Stockholm Convention, through the Persistent Organic Pollutants Review Committee aims at protecting human health and the environment from POPs, while being mindful of the Precautionary Approach as set forth in Principle 15 of the Rio Declaration on Environment and Development. It seeks to adopt measures to eliminate releases from intentional POP production and use, to reduce or eliminate releases from unintentional POP production, and to reduce or eliminate POP releases from its stockpiles and wastes in support 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.

Therefore, in accordance with paragraph 9 of Article 8 of the Convention the Committee recommends to the Conference of the Parties to consider listing and specifying the related control measures of hexa- and hepta-, bromodiphenyl ether congeners in Annex A of the Convention, as described above, and using as markers for enforcement purposes: BDE153/154 (hexaBDE) and BDE175/183 (heptaBDE).

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