Government of Canada Gouvernement du Canada

RISK MANAGEMENT STRATEGY

FOR

POLYBROMINATED DIPHENYL ETHERS

(PBDEs)

PBDE	**CAS No.***
tetrabromodiphenyl ethers (tetraBDE)	40088-47-9
pentabromodiphenyl ethers (pentaBDE)	32534-81-9
hexabromodiphenyl ethers (hexaBDE)	36483-60-0
heptabromodiphenyl ethers (heptaBDE)	68928-80-3
octabromodiphenyl ethers (octaBDE)	32536-52-0
nonabromodiphenyl ethers (nonaBDE)	63936-56-1
decabromodiphenyl ether (decaBDE)	1163-19-5

Chemicals Sectors Directorate
Environmental Stewardship Branch

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* Chemical Abstracts Service (CAS) Registry Numbers

Canada

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1. ISSUE

Ecological and human health screening assessments were conducted for polybrominated diphenyl ethers (PBDEs) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999). Included in these screening assessments are seven PBDE congener groups (tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE, nonaBDE and decaBDE) that are contained in three commercial PBDE mixtures. A summary of the final ecological and human health screening assessment reports was published in Part I of the *Canada Gazette* on July 1, 2006 (Canada, Department of the Environment, Department of Health 2006).

The ecological screening assessment report (Environment Canada 2006) concludes that PBDEs are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. The screening assessment recommends that PBDEs with four or more bromine atoms (tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE, nonaBDE and decaBDE congeners) be added to the List of Toxic Substances in Schedule 1 of CEPA 1999. On December 27, 2006, the order to add these PBDE congeners to the List of Toxic Substances in Schedule 1 of CEPA 1999 was published in the *Canada Gazette*, Part II.

It also concludes that tetra-, penta- and hexaBDE congeners meet the criteria for persistence and bioaccumulation, as defined by the *Persistence and Bioaccumulation Regulations* of CEPA 1999, and their presence in the environment results primarily from human activity. Therefore, tetraBDE, pentaBDE and hexaBDEs meet the conditions set out in CEPA 1999 for mandatory addition to the Virtual Elimination List.

The human health risk assessment (Health Canada 2006) concludes that worst-case estimates of the exposure of Canadians to PBDEs are much lower than those that caused health effects in animals. It is noted that the control measures that Environment Canada will be proposing to protect the environment from PBDEs are expected also to reduce human exposure. With the upward trend noted in the levels of human exposure to PBDEs, Health Canada is fully supportive of taking control measures to prevent exposure to PBDEs from increasing to a level that could pose a risk to the health of Canadians.

Since the completion of the ecological screening assessment, a large amount of new information has been published regarding the accumulation of decaBDE in biota and the potential transformation of decaBDE to persistent and bioaccumulative products. This information has been summarized and evaluated in the draft State of Science Report on the Bioaccumulation and Transformation of DecaBDE (Environment Canada 2009). The draft report concludes that decaBDE may accumulate to high and problematic levels in organisms, and may transform into bioaccumulative and/or potentially bioaccumulative substances. In addition to risk management measures that are either under development or have already been implemented for PBDEs, the outcome of the review provides justification for the development of additional regulatory controls to restrict the use of decaBDE in manufactured and imported products.

2. BACKGROUND

2.1 Substance Information

Polybrominated diphenyl ethers (PBDEs) are a class of substances that are used as flame retardants in a wide variety of products. These substances contain an identical base structure, but differ in the number of attached bromine atoms (ranging from 1 to 10). The following seven PBDE congener groups, present on the Canadian Domestic Substances List, were assessed by Environment Canada and Health Canada:

PBDE	**CAS No.***
tetrabromodiphenyl ethers (tetraBDE)	40088-47-9
pentabromodiphenyl ethers (pentaBDE)	32534-81-9
hexabromodiphenyl ethers (hexaBDE)	36483-60-0
heptabromodiphenyl ethers (heptaBDE)	68928-80-3
octabromodiphenyl ethers (octaBDE)	32536-52-0
nonabromodiphenyl ethers (nonaBDE)	63936-56-1
decabromodiphenyl ether (decaBDE)	1163-19-5

* Chemical Abstracts Service (CAS) Registry Numbers

All seven PBDE groups assessed are highly persistent and many PBDE congeners have been detected in the Arctic, thus indicating that they are subject to long-range environmental transport (Environment Canada 2006). Each satisfies the requirements for persistence as defined in the *Persistence and Bioaccumulation Regulations* under CEPA 1999 (Canada 2000).

In addition, based on the final ecological screening assessment report, tetra-, penta- and hexaBDE congeners are highly bioaccumulative and satisfy the criteria for bioaccumulation under these same Regulations. As these PBDEs also result primarily from human activity, they meet the conditions set out in subsection 77(3) of CEPA 1999 for mandatory addition to the Virtual Elimination List.

On March 28, 2009, the results of a draft State of the Science report on decabromodiphenyl ether (decaBDE) were published in the *Canada Gazette*, Part I. The purpose of the report is to provide an updated analysis of the bioaccumulation and environmental transformation of decabromodiphenyl ether, to be considered in the context of the information and analyses already published in the final screening assessment on PBDEs.

The draft State of Science Report found no measured or experimental evidence supporting that decaBDE meets the bioaccumulation criteria as defined under the *Persistence and Bioaccumulation Regulations* under CEPA 1999. However, several studies indicate that decaBDE is available for uptake in organisms and may accumulate to high and potentially problematic levels in certain species. Although uncertainties remain, it is reasonable to conclude that decaBDE may contribute to the formation of bioaccumulative and/or potentially bioaccumulative transformation products such as lower-brominated PBDEs, including tetra-, penta- and hexaBDEs, in organisms and in the environment.

PBDEs are considered to present a negligible risk with respect to atmospheric processes such as global warming, stratospheric ozone depletion and ground-level ozone formation. This is due to the tendency of PBDEs entering the environment to bind to the organic fraction of particulate matter, notably in sediment and soil, with only small amounts partitioning into water and air.

2.2 Chronology of the PBDE File

Numerous actions have been completed by the Government of Canada concerning PBDEs; key milestones to date are summarized below:

Milestone	**Date**
Summary of the final ecological and human health screening assessment reports published in the *Canada Gazette*, Part I (CGI)	July 1, 2006
Proposed Risk Management Strategy posted online for public comment	Sept. 20, 2006
Proposed *Polybrominated Diphenyl Ethers Regulations* published in the *Canada Gazette,* Part I	Dec. 16, 2006
60-day electronic consultation on proposed PBDE regulations	Dec. 16, 2006-Feb. 14, 2007
Final Order Adding to the List of Toxic Substances published in the *Canada Gazette*, Part II (CGII)	Dec. 27, 2006
Final *Polybrominated Diphenyl Ethers Regulations* (PBDE Regulations) made and in force	June 19, 2008 (published in CGII July 9, 2008)

2.3 Production, Import, Export and Uses of PBDEs

PBDEs are sold in three commercial mixtures—PentaBDE, OctaBDE and DecaBDE—each containing two or more of the seven PBDE congener groups. Although the commercial formulations vary in composition, each PBDE congener group is typically present within a certain range. Typical compositions of the commercial mixtures are shown in Figure 1.

Figure 1 – Typical compositions of the PBDE commercial mixtures[1]

Commercial Mixtures	PBDE Congener Groups						
	tetraBDE	pentaBDE	hexaBDE	heptaBDE	octaBDE	nonaBDE	decaBDE
PentaBDE	24-38%	50-62%	4-12%	Trace	-	-	-
OctaBDE	-	0.5%	12%	45%	33%	10%	0.7%
DecaBDE	-	-	-	-	Trace	0.3-3%	97-98%

PBDE congeners targeted for Virtual Elimination

PBDEs have never been manufactured in Canada. Due to voluntary phase-out by industry, production in the United States of the PentaBDE and OctaBDE commercial mixtures ceased at the end of 2004, followed by phase-out on an international basis. The only commercial mixture still manufactured, outside of Canada (mainly in the United States), is DecaBDE. DecaBDE is imported and enters Canada:

- as chemical formulations from foreign producers;
- in resins, polymers or substrates containing DecaBDE;
- in semi-finished articles, materials or components containing DecaBDE; or
- in finished products containing DecaBDE.

In general, plastics are the primary end use for flame retardants owing to the inherent flammability of many polymers. PBDEs have seen widespread use in electrical and electronic goods, motor vehicles, aircraft and construction products. Smaller markets include textiles, adhesives and sealants, rubber products and coatings.

There are substantial differences in the use patterns of the three commercial mixtures.

PentaBDE Commercial Mixture

The PentaBDE commercial mixture was primarily used in polyurethane resins, particularly foams. The downstream industries that used such products were primarily the users of flame-retardant polyurethane (PUR) foams, e.g. furniture and bedding manufacturers, manufacturers of moulded and slab foams for automotive parts, manufacturers of carpets and rugs with polyurethane underlay, and manufacturers of building construction foam.

OctaBDE Commercial Mixture

The OctaBDE commercial mixture was primarily used in acrylonitrile butadiene styrene (ABS) resins. The downstream industries that used OctaBDE-containing ABS were the manufacturers of electrical and electronic products, since such resins

[1] For the purposes of this document, PBDE commercial mixtures are capitalized to distinguish from the congeners they contain (i.e. “PentaBDE” vs. “pentaBDE”).

were used for computer housings, appliances, automotive parts and communication equipment.

DecaBDE Commercial Mixture

The DecaBDE commercial mixture is used primarily in polystyrene (PS), particularly high impact polystyrene (HIPS) and to a lesser extent in a number of other resins. These DecaBDE flame retardant resins are predominantly used in electrical and electronic products. In addition, DecaBDE commercial mixture is also used in the production of textiles that require flame retardant properties, such as upholstery and drapery fabrics. Reports indicate that 80–90% of DecaBDE (Cheminfo 2008) is used in electrical and electronic products, with textile applications accounting for most of the remaining 10–20%. Indications are that DecaBDE is currently no longer used for residential upholstered furniture or for personal clothing.

While information gathered in 2001 through an Environment Canada use pattern survey revealed that 16 Canadian manufacturers reported importing approximately 1300 tonnes of PBDEs in 2000 (Environment Canada 2003), the use of PBDEs in Canada since then has significantly declined. The PentaBDE and OctaBDE commercial mixtures are no longer available worldwide and discussions with industry indicate that the amount of DecaBDE imported into Canada has decreased. Manufacturers of DecaBDE have reported that, between 2004 and 2008, fewer than 100 tonnes per year of the DecaBDE commercial mixture were imported into Canada. The amount of DecaBDE imported to Canada embedded in manufactured products is considerably higher, with some reports estimating that up to 6000 tonnes of DecaBDE embedded in products are imported to Canada on a yearly basis (Cheminfo 2008). Similarly, while the use of the PentaBDE and OctaBDE commercial mixtures have been phased out, they may be present in older materials and manufactured products (i.e. manufactured prior to 2006), either currently still in use or imported into Canada.

Not all imported PBDEs remain within Canada, as some are exported from Canada in finished products, most of which are destined for the United States.

3. WHY WE NEED ACTION

According to the ecological assessment report (Environment Canada 2006), PBDEs are entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. PBDEs have been detected in a variety of species worldwide and evidence from many studies indicates that levels of certain PBDEs in biota in North America (including the Canadian Arctic) are increasing steadily and substantially over time. The assessment report indicates that the greatest potential risks from PBDEs in the Canadian environment are the secondary poisoning of wildlife from the consumption of prey containing elevated concentrations of PBDEs and effects on benthic organisms that may result from elevated concentrations of certain PBDEs in sediments.

In addition, the draft State of Science Report (Environment Canada 2009) found that decaBDE is available for uptake and has the potential to accumulate in biota to high levels and can contribute, in some cases, to a significant proportion of the PBDE burden in biological tissues. The analysis also concludes that decaBDE likely contributes to the formation of bioaccumulative and/or potentially bioaccumulative transformation products such as lower-brominated BDEs in organisms and in the environment.

Given the conclusions of both the final ecological screening assessment and the draft State of the Science report on decaBDE, PBDEs are and will be managed under the provisions of CEPA 1999 with the objectives of preventing the introduction of their manufacture in Canada and minimizing their release into the environment from all sources in Canada. For tetra-, penta-, and hexaBDE congeners, the ultimate environmental objective is virtual elimination as they result primarily from human activity, and meet the criteria for bioaccumulation, persistence and toxicity as defined under CEPA 1999.

4. PRESENCE IN THE CANADIAN ENVIRONMENT AND EXPOSURE SOURCES

There are no known natural sources of PBDEs. PBDEs are potentially released to the environment throughout their lifecycle, from the chemicals themselves and from products containing them. PBDEs may enter the environment through treated or untreated municipal or industrial wastewater discharges to surface water and also through leachate from landfills and municipal incineration when products and materials containing these substances are sent for final disposal. PBDEs may also be released directly to air, land and surface water when products containing PBDEs are manufactured and during their use. These exposure sources are discussed in this section.

Products that were treated with PentaBDE or OctaBDE prior to phase-out that remain in use will continue to be a source of release to the environment, primarily via disposal. Potential releases of the DecaBDE commercial mixture from plastics are mainly associated with product disposal as well. Potential releases of the DecaBDE commercial mixture associated with textile applications appear to be spread relatively evenly throughout the life cycle, with most releases being associated with textile processing/finishing and releases during the product service life.

4.1 Industrial and Manufacturing Processes

PBDEs are not manufactured in Canada. Only the DecaBDE commercial mixture remains in use, while the other PBDEs (Penta- and OctaBDE mixtures) have been phased out internationally.

DecaBDE is primarily used in industrial and manufacturing processes to treat plastics and textiles in order to impart flame retardancy to products.

The release of PBDEs from these sources can occur during the handling of PBDEs prior to formulation, during the formulation and processing of PBDEs into resins and during the conversion of these resins into products. Releases from industrial or manufacturing processes will primarily be to wastewater, to air through vaporization and to land from spills and waste disposal. The majority of air releases from manufacturing facilities would rapidly partition to soil and sediments (from 75 to > 99%) and remain near their point of release (ToxEcology Environmental Consulting 2003).

4.2 Product Use

The day-to-day use of products containing PBDE flame retardants has the potential to release PBDEs to the environment. Emission to air has been identified as a potential source of release due to the vaporization of PBDEs from products. Air releases may be one pathway for PBDE presence in dust. Particle emissions may also result from aging and wear of products (i.e. foam particles from furniture).

PBDEs are released to wastewater, some of which makes its way to the municipal treatment facility through the disposal of wash water containing PBDEs present in dust. While potential releases to wastewater have also been identified from the washing of textiles, PBDEs are generally used in textiles such as upholstery fabrics, carpets, curtains and tent materials, which are not subject to frequent washing (ToxEcology Environmental Consulting 2003).

4.3 Product Disposal

The term “products” as used in this report refers to articles to which PBDE commercial mixtures have been added. Thus, products may include furniture, carpet backing, textiles, televisions, electronic equipment, computer housings and automotive parts.

The majority of PBDEs used in products remain in the product matrices at the time of disposal. At present, in Canada, the vast majority (> 95%) of solid articles containing PBDEs are disposed of in landfills[2] (ToxEcology Environmental Consulting 2003).

The release of PBDEs occurs when products containing PBDEs are disposed of in landfill sites at the end of their operational life or, in the case of some products, are sent to recycling facilities for processing. Releases may occur at various points during disposal and recycling operations including handling, transport and product breakup at collection sites. While municipal incineration of solid waste is a potential source of PBDE emissions, incineration represents less than 5% of solid waste disposal in Canada (ToxEcology Environmental Consulting 2003).

[2] Though the majority of electronic equipment containing PBDEs is sent to landfills, an increasing amount of end of life (EOL) electronics is subject to extended producer responsibility (EPR) programs. These programs are set up by provincial or regional governments in concert with industry, most of which are mandatory. These programs support waste reduction, reuse and recycling, and are designed to encourage education in use and pollution prevention related to toxic substances. Although PBDEs are not individually identified in the EPR programs, these programs target products that may contain PBDEs.

Landfilling may result in releases of PBDEs to soil, surface water and potentially to groundwater. Based on their properties, it is assumed that PBDEs will partition to soil and sediments and remain close to the point of release. Releases from landfills are dependent on the concentration of these substances remaining in the products at their end of life, landfilling practices and the existence of leachate collection systems.

It should be noted that potentially PBDE-contaminated leachate collected from landfills is normally taken to municipal treatment facilities. Since PBDEs are not removed at the treatment process at these facilities, the PBDEs are either passed directly through and into the downstream aquatic environment or else are contained in bio-solid sludge that is either applied to land or returned to the landfill that originally generated the leachate (Cheminfo 2008).

4.4 Long-Range Transport

PBDEs have been detected in remote sites around the world, including the Canadian Arctic where they are present at elevated levels (e.g. in air, lakes and in the tissues of some living organisms), suggesting that the PBDEs undergo long-range transport (Environment Canada 2006). This long-range transport of PBDEs through the atmosphere or through the ocean currents is a potential source of PBDE loadings to the Canadian environment. Manufacturing of PBDEs, manufacturing processes using PBDEs, as well as use and disposal of formulations and products outside of Canada are expected to contribute to the presence of PBDEs in Canada.

4.5 Transformation of decaBDE

DecaBDE likely contributes to the formation of bioaccumulative and/or potentially bioaccumulative transformation products such as lower brominated BDEs in organisms and in the environment. Numerous laboratory studies provide evidence that decaBDE may break down in the environment, particularly as a result of photodegradation and biodegradation. Studies of photodegradation of decaBDE sorbed to solids in aqueous and dry systems have demonstrated transformation of decaBDE to tri- to nonaBDEs. Biodegradation studies have also shown the potential breakdown of decaBDE mainly to nona-, octa- and heptaBDEs (Environment Canada 2009).

5. OVERVIEW OF EXISTING INTERNATIONAL INITIATIVES ON PBDEs

There are numerous regulatory initiatives concerning PBDEs that have been enacted in various jurisdictions around the world, the majority of which are targeting PBDEs contained in electronic and electrical equipment (EEE). Some of these initiatives contain restrictions on the content of PBDEs in products.

5.1 European Initiatives

5.1.1 European Commission

Under the European Union (EU) RoHS (Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) Directive 2002/95/EC (European Parliament and Council of the European Union 2003a), six substances (or class of substances), including PentaBDE and OctaBDE commercial mixtures, have been restricted within specified electronic and electrical equipment (EEE) product types since July 1, 2006. As of July 1, 2008, use of DecaBDE mixture has also been restricted, which means that all 7 PBDE congener groups ((tetraBDE, pentaBDE, hexaBDE, heptaBDE, octaBDE, nonaBDE and decaBDE congeners) are covered under the Directive as of that date. For PBDEs, the restriction is for content within products greater than 0.1% by weight (European Parliament and Council of the European Union 2005) at the homogeneous[3] level of a product. A draft proposal to update the EU RoHS Directive (Commission of the European Communities 2008) was published in late 2008, aimed at increasing the number of product groups affected by the Directive, in addition to changes in labeling requirements and the streamlining of some requirements. There are currently no exemptions affecting PBDEs in the Directive.

The European Union's Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC (European Parliament and Council of the European Union 2003b) has been in force since January 2003 (initially adopted by a number of EU countries in August 2005). The WEEE directive aims to prevent the generation of electrical and electronic waste and to promote reuse, recycling and other forms of recovery in order to reduce the quantity of such waste being disposed of through landfilling or incineration. The WEEE Directive requires EEE industry producers to take back and recycle their products, with targets for the amount of recycling achieved in addition to various other requirements. A requirement of WEEE is that plastics containing brominated flame retardants (including PBDEs) be removed from the EEE waste and necessary measures be taken to ensure the resulting waste is disposed of without endangering human health or the environment. The EU WEEE Directive is linked to the EU RoHS Directive in that the product types affected by EU RoHS are contained in Annex 1A[4] of the EU WEEE Directive.

As a consequence of requirements of both the RoHS Directive and the WEEE Directives, methods have emerged in Europe for the treatment of plastics to remove BFRs (including PBDEs). These emerging technologies enable the use of recycled plastics into new EEE products, while still meeting the PBDE content restriction of the RoHS.[5]

[3] The definition of a homogeneous material can be found in the Frequently Asked Questions on EU RoHS and EU WEEE (European Commission 2006) and in the proposal to update the EU RoHS Directive (Commission of the European Communities 2008).
[4] Annex 1A of the EU WEEE Directive (European Parliament and Council of the European Union 2003b) can be found on page 33 of that document.
[5] For more information, see http://www.axionrecycling.com.

The European Union Directive 2003/11/EC (European Parliament and Council of the European Union 2003c) has been in force since August 15, 2004. The Directive prohibits the use of PentaBDE and OctaBDE commercial mixtures in all manufactured or imported products at concentrations higher than 0.1% by mass.

5.1.2 Other European Countries

Some other European countries that are not part of the European Union, including Switzerland, Iceland, Liechtenstein and Turkey have also essentially adopted the EU RoHS regulations, with some country-specific variations.

Norway has enacted regulations restricting the use of DecaBDE in all manufactured products, with the exception of transportation applications (the restriction applies to concentrations > 0.1% by weight, same as in EU RoHS). The regulations have been in force since April 1, 2008. In addition, in Norway, products containing more than 0.25% PentaBDE, OctaBDE or DecaBDE commercial mixtures are classified as hazardous waste when they are discarded.

5.2 American Initiatives

In June 2006, the United States Environmental Protection Agency (U.S. EPA) issued a Significant New Use Rule (SNUR)[6] that requires notification to the U.S. EPA 90 days prior to US manufacture or import, for any use, of the commercial PentaBDE and OctaBDE mixtures for prior evaluation.

Trends in releases of decaBDE are also being followed by the United States through the Toxics Release Inventory. In June 2008 the U.S. EPA released the final Integrated Risk Assessment Information System (IRIS)[7] assessment of decaBDE.

The EPA's Design for the Environment (DfE)[8] Program, which began in the early 1990's, works to provide information on substituting safer chemicals and provides for assessment of alternatives, including alternatives to PBDEs.

5.2.1 Initiatives by Individual U.S. States

Laws have been enacted and legislation introduced relating to PBDEs in many U.S. States (The Toxics Steering Group and Polybrominated Diphenyl Ethers Subcommittee 2008), including California, Maine, Michigan, New York, Hawaii, Washington, Maryland, Rhode Island, Oregon and Illinois. These legislative initiatives initially addressed the PentaBDE and OctaBDE commercial mixtures. However, several states are now proposing restricted uses of DecaBDE as well. Many of the legislative initiatives concerning DecaBDE are still under discussion by the States in question. However, two

[6] For more information, see http://www.epa.gov/opptintr/newchems/pubs/cnosnurs.htm.
[7] For more information, see http://cfpub.epa.gov/ncea/iris/index.cfm.
[8] For more information, see http://www.epa.gov/dfe/.

States, Washington and Maine, have signed into law legislation prohibiting the use of DecaBDE in certain consumer products:

- The state of Washington has restricted the manufacture, sale, and use of DecaBDE in mattresses as of January 2008. That restriction has now been extended to televisions, computers and residential upholstered furniture, effective January 2011.

- The state of Maine has restricted the use of DecaBDE in mattresses and upholstered furniture as of January 1, 2008. The state will be phasing in that restriction for televisions and other plastic-cased electronics by January 1, 2010.

5.3 Asian Initiatives

Japan has a law concerning the reporting of releases of specific chemical substances and promoting improvements in their management. Under this law, yearly reports are required on the volumes of the DecaBDE commercial mixture imported and used and the quantities released to the environment.

China's Ministry of Information Industries issued the Management Methods for the Prevention and Control of Pollution Caused by Electronic Information Products (sometimes referred to as CRoHS). The ministry is taking a phased approach to managing the same six substances restricted under EU RoHS. The first phase, in force since March 1, 2007, requires labeling and disclosure of the content of the substances within EEE products, but imposes no restrictions. The second phase, which will include restrictions, has yet to be implemented.

Korea implemented a law which covers end-of-life and EU-RoHS-type restrictions on electronic products and vehicles. Exemptions, limit values and restricted substances are the same as the EU RoHS Directive. As of July 1, 2008, a restriction similar to EU RoHS, including for PBDEs, came into force for a subset of the product types included in EU RoHS.

5.4 International Agreements

Canada is actively involved in the process of adding commercial PentaBDE (c-PentaBDE) and OctaBDE (c-OctaBDE) to two international agreements: the Stockholm Convention on Persistence Organic Pollutants (POPs) and the Long-Range Transboundary Air Pollution (LRTAP) Convention. These mixtures are being considered for addition to these conventions as certain PBDEs contained in them have the ability to undergo long-range transport, are persistent and bioaccumulative and are deemed to have sufficient indications that they are likely to cause adverse effects as a result of their long-range transport.

5.4.1 Stockholm Convention on Persistent Organic Pollutants (POPs)

The Stockholm Convention entered into force in May 2004 and is an international legally binding agreement that has been ratified by 128 countries, including Canada. Under this convention, Parties are bound to take action to prohibit the manufacture and import of the chemicals listed on Annexes A and B of the convention.

Under the convention, the Persistent Organic Pollutants Review Committee (POP RC) has concluded that both c-PentaBDE and c-OctaBDE are persistent organic pollutants. Risk management evaluations for c-PentaBDE and c-OctaBDE have been prepared. The Review Committee decided to recommend to the fourth Conference of the Parties (COP4) that it consider listing c-PentaBDE (including tetra- and penta-BDEs) and c-OctaBDE (including hexa- and hepta-BDEs) in Annex A of the Stockholm Convention, without exemptions. Listing in Annex A obliges the Parties, including Canada, to eliminate the production, use, export and import of the chemical. In May 2009, COP4 is expected to make decisions on these recommendations.

5.4.2 United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) Convention's Protocol on Persistent Organic Pollutants (POPs) ("LRTAP Convention")

The LRTAP Convention entered into force in 1983 and is an international legally binding agreement that has been ratified by 51 countries, including Canada. The Convention requires all Parties to endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution.

Parties to the LRTAP Convention have concluded that c-PentaBDE and c-OctaBDE are persistent organic pollutants. An assessment and management review of c-PentaBDE and c-OctaBDE has been completed by the UNECE's LRTAP. In December 2008, there was consensus on adding c-PentaBDE and c-OctaBDE to Annex I of the POPs Protocol to eliminate their production and use. Related discussions on exempted uses are ongoing.

5.5 Environmental Stewardship Programs

In May 2004, the Voluntary Emissions Control Action Programme (VECAP)[9] was initiated by the British Plastics Federation and the Bromine Science and Environmental Forum. Under this program, a voluntary code of practice was developed to manage, monitor and minimize industrial emissions of brominated flame retardants into the environment through partnership with small and medium-sized enterprises. The initial focus of the program was on textile and plastics industries in Europe, but implementation has spread to the United States and Japan, and now Canada, as the draft Performance Agreement on DecaBDE (section 8.3) is modeled after VECAP.

[9] Further information on VECAP is available at http://vecap.org/.

A program called the Electronic Product Environmental Assessment Tool (EPEAT)[10] was created by a multi-stakeholder group in the United States. EPEAT is a procurement tool used to identify desktop computers, notebooks and monitors that satisfy established environmental criteria, including conformance to EU RoHS.

Environment Canada's Environmental Choice Program has recently concluded a partnership with the US-based EPEAT program by which electronic manufacturers have the option to apply for the third-party-verified EcoLogo certification for products that qualify the silver and gold EPEAT registration levels. To qualify for the EPEAT registration and EcoLogo certification of personal computer products (namely desktop personal computers, notebook personal computers and personal computer monitors) manufacturer's products must comply with a number of performance criteria including the provisions of the European RoHS Directive 2002/95/EC for the restriction on certain hazardous substances in electronic equipment (which include PBDE).[11].

6. CONSIDERATIONS

PBDEs are used in products to slow the ignition and spread of fire. In working towards the risk management objectives (see section 7.2), there is a need to weigh one potential risk against another. Flame retardancy is important to protect human safety and avoid social and economic losses due to fire. In addition, many toxic substances are released during fires; hence, flame retardancy can yield net environmental benefits. Cost-effective substitutes or alternatives must be available to meet the relevant fire safety standards.

6.1 Alternative Chemicals

Chemical alternatives to PBDEs are available for the vast majority of industrial and manufacturing applications, and these vary by application. However, several issues need to be addressed as some potential alternatives are:

- currently under scrutiny themselves;
- new proprietary chemicals for which data on environmental and health effects are very limited;
- more costly; and
- less effective; hence much higher levels are required and products may be less likely to meet flammability standards.

6.2 Alternative Techniques

The need for PBDEs can be reduced through the use of alternative techniques such as:

[10] Further information on EPEAT is available at http://www.epeat.net/.

[11] Further information on the EcoLogo program is available at http://www.ecologo.org/en/.

- the use of materials that are less prone to fire hazard in electronics equipment (such as aluminum or “super-plastics” with very high oxygen requirements for combustion);
- the use of barrier fabrics, wrappings or coatings for foams to replace chemical flame retardants;
- the use of inherently flame retardant fibres.

Some of these alternative techniques present challenges, such as the increased weight of final products.

Some of these alternative techniques are promoted and encouraged by Design for the Environment (DfE) programs (see section 5.2). DfE programs also promote innovation, informed substitution, alternatives analysis, and green chemistry.

7. PROPOSED OBJECTIVES

7.1 Environmental Objective

The environmental objective for all seven PBDE congener groups is to reduce the concentrations of PBDEs in the Canadian environment to the lowest level possible.

For tetraBDE, pentaBDE and hexaBDE congeners, the ultimate environmental objective is virtual elimination as defined under subsection 77(4) of CEPA 1999 because:

- the final screening assessment report concludes that these congeners meet the criteria under section 64 of CEPA 1999;
- tetraBDE, pentaBDE and hexaBDEs meet the criteria for persistence and bioaccumulation as defined by the *Persistence and Bioaccumulation Regulations* made under CEPA 1999;
- the presence of these substances in the environment results primarily from human activity; and
- PBDEs are not a naturally occurring radionuclide or naturally occurring inorganic substances.

As a result, the Government of Canada will follow the process specified in CEPA 1999 for substances that meet the criteria for virtual elimination.

7.2 Risk Management Objectives

The proposed risk management objective for PBDEs is to prevent the introduction of their manufacture in Canada and to minimize their releases into the environment from all sources in Canada. This includes restrictions on the importation of the PBDE substances and products manufactured or imported into Canada that contain PBDEs.

8. RISK MANAGEMENT INSTRUMENTS/TOOLS, AND COMPLEMENTARY MEASURES

Given the conclusions of both the final ecological screening assessment on PBDEs and the draft State of Science report on decaBDE, as outlined in section 1 of this report, the Risk Management Strategy for PBDEs uses a multi-instrument approach to minimize releases of PBDEs from all sources to the environment. The approach combines regulatory and voluntary measures, the development of environmental quality guidelines, international co-operation and ongoing monitoring as described in the following sections.

8.1 Polybrominated Diphenyl Ethers Regulations

The *Polybrominated Diphenyl Ethers Regulations* (PBDE Regulations) were made under CEPA 1999 and came into force on June 19, 2008. The regulations prohibit the manufacture of PBDEs (i.e. tetra-, penta-, hexa-, hepta-, octa-, nona-, and decaBDE congeners) in Canada. The regulations also prohibit the manufacture, use, sale, offer for sale and import of mixtures, polymers and resins containing those PBDEs that meet the criteria for virtual elimination (tetra-, penta- and hexaBDE congeners) under CEPA 1999.

As the PentaBDE and OctaBDE commercial mixtures contain those PBDEs that meet the criteria for virtual elimination, their sale, import and use is prohibited in Canada.

As a result of the manufacturing prohibition in the PBDE Regulations, the manufacture of all of the PBDE commercial mixtures, including DecaBDE, is also prohibited in Canada.

8.2 Regulatory controls to restrict PBDEs in manufactured and imported products containing tetra-, penta-, hexa-, hepta-, octa-, nona- and decaBDE congeners ("PBDE product regulatory controls")

The PBDE product regulatory controls, to be made under CEPA 1999, are currently under development. The regulatory controls are intended to be two-tiered, with one set of provisions for products containing tetra-, penta-, hexa-, hepta-, and octaBDE congeners (contained in PentaBDE and OctaBDE commercial mixtures) and another for products containing nona- and decaBDE congeners (contained in the DecaBDE commercial mixture).

8.2.1 Provisions for tetra-, penta-, hexa-, hepta-, and octaBDE congeners

Regulatory controls for tetra-, penta-, hexa-, hepta-, and octaBDE congeners (contained in the Penta- and OctaBDE commercial mixtures) would aim to prohibit the manufacture, use, sale, offer for sale and import of all new products containing these substances at a concentration of greater than 0.1% by weight. These controls are preventive in nature: as the PentaBDE and OctaBDE commercial mixtures have been

phased out internationally, these controls aim to prevent any possible re-introduction of products containing these substances into Canada.

8.2.2 Provisions for nona- and decaBDE congeners in new electronic and electrical equipment

Regulatory controls for nona- and decaBDE congeners (contained in the DecaBDE commercial mixture) would aim to prohibit the manufacture, use, sale, offer for sale and import of specified new electronic and electrical (EEE) products containing these substances at a concentration greater than 0.1% by weight. While taking into consideration the Canadian context, the intent of these regulatory controls would be to align with existing international controls on DecaBDE, most notably the European Union RoHS Directive 2002/95/EC as described in section 5.1.1 (European Parliament and Council of the European Union 2003a).

It is the intent of the product regulatory controls concerning DecaBDE to align with EU RoHS in at least three important aspects: (i) the controls would apply to new products (based on the date of manufacture), (ii) the concentration limit of 0.1% by weight would be determined applying a similar definition of "homogeneous material",[12] and (iii) the regulatory controls would apply to the same product types subject to the RoHS Directive (as referenced in the EU WEEE Directive Annex 1A[13]).

Consideration in the regulatory controls would be given to provisions that allow for the use of non-compliant material in certain cases, e.g. spares/repair parts for use in existing equipment, or for expansion of existing installations. While no labelling or systematic reporting requirements are currently envisaged, careful consideration needs to be given to provisions related to testing and monitoring for compliance.

The regulatory controls would target the largest sources of releases of DecaBDE to the environment (product use and subsequent disposal), recognizing that upwards of 80% of DecaBDE (the only PBDE commercial mixture still being manufactured) is used for treating plastic components/resins used in electrical and electronic equipment (EEE) (Cheminfo 2008). This approach further recognizes that the EEE sector is global in nature. With controls in place or being introduced for such products in many jurisdictions around the world, moving towards an internationally uniform set of restrictions should lead to market efficiencies and increased compliance.

8.3 Proposed Performance Agreement for DecaBDE used at Canadian Manufacturing Facilities

A Performance Agreement is being developed with industry on a voluntary basis to monitor and minimize the release of the Decabromodiphenyl Ether (DecaBDE) commercial mixture (containing nona- and decaBDE congeners) from Canadian plastic

[12] The definition of a homogeneous material can be found in the Frequently Asked Questions on EU RoHS and EU WEEE (European Commission 2006) and in the proposal to update the EU RoHS Directive (Commission of the European Communities 2008).
[13] Annex 1A of the EU WEEE Directive (European Parliament and Council of the European Union 2003b) can be found on page 33 of that document.

and textile manufacturing operations where DecaBDE is used or handled. Parties to the Agreement will adopt a code of practice that sets numerical performance objectives for reducing releases of DecaBDE to the environment. The agreement also makes provisions for evaluating industry performance through third party verification.

A draft of the proposed Performance Agreement was published for public consultation on March 28, 2009. For further information please consult the following Internet address:
http://www.ec.gc.ca/epa-epe/decaBDE/consult_03_2009/en/index.cfm

8.4 Monitoring of PBDEs

The Government of Canada is monitoring PBDEs in the Canadian environment and in landfills and wastewater treatment plants. This monitoring information will be used to assess the progress and effectiveness of the risk management actions taken by the Government of Canada and to better understand potential environmental exposure from these sources. Biomonitoring of PBDEs is also underway to continue to monitor levels of PBDEs in humans, including vulnerable populations such as pregnant women and northern communities.

Furthermore, the National Pollutant Release Inventory (NPRI)[14] Program of the Government of Canada has collected data on decaBDE since 1994. The NPRI is Canada's legislated, publicly accessible inventory of pollutants released, disposed of and sent for recycling by facilities across the country. Industrial, institutional and commercial facilities which meet NPRI reporting requirements are required to report under the *Canadian Environmental Protection Act, 1999* (CEPA 1999). For decaBDE, the reporting criteria are based on the number of hours worked by employees at the facility (20 000 hour employee threshold, equivalent to 10 full-time employees) and the quantity of the substance used (10 000 kg of decaBDE must have been manufactured, processed or otherwise used). Some exemptions apply to these criteria. The program's main objectives are to inform the public, encourage voluntary reduction, monitor progress and set priorities for action.

8.5 Development of Federal Environmental Quality Guidelines for PBDEs

The Government of Canada is developing federal environmental quality guidelines for PBDEs in the appropriate media as targets for acceptable environmental quality, to assist in the interpretation of monitoring data, and to serve as performance indicators of risk management actions.

These federal environmental quality guidelines (FEQGs) will provide voluntary benchmarks for the quality of the environment; they will serve as an aid to pollution prevention by providing targets for acceptable environmental quality. FEQGs will assist in deciding the ecological significance of concentrations of chemical substances currently found in the environment (monitoring of water, sediment and biological tissue).

[14] Further information on NPRI is available at http://www.ec.gc.ca/pdb/npri/.

As it is expected that PBDEs entering the environment will partition primarily to sediment, soil and biological tissue, with smaller amounts into water and air, the development of FEQGs for sediment, soil and biological tissue are considered priorities and their development is currently underway.

8.6 Development of a Management Strategy for PBDE-containing Products at End-of-life

The Government of Canada will work closely with its provincial and municipal counterparts to minimize the quantities of PBDEs released to the Canadian environment through the disposal or recycling of products containing PBDEs. Options will be explored taking into consideration the fact that the federal, provincial and territorial governments have authority to regulate waste management in Canada in accordance with their constitutional powers and law-making authorities. The risk management strategy for the waste sector is currently under development.

9. PROPOSED CONSULTATION APPROACH

This revised Risk Management Strategy for PBDEs will be subject to a 60-day public consultation period following publication. Comments received on the revised Strategy will inform the development of control instruments.

The development of the regulatory controls to address manufactured and imported products containing PBDEs will follow the Government of Canada regulatory process, including publication in the *Canada Gazette*, Part I, for further consultation.

The draft performance agreement to minimize releases of the DecaBDE commercial mixture (containing nona- and decaBDE) to the environment from manufacturing operations in Canada, also being published at this time, will follow the Government of Canada consultative process and include a 60-day public comment period.

10. NEXT STEPS / PROPOSED TIMELINE

Revised Risk Management Strategy for PBDEs

Actions	Date
Publication of the revised Risk Management Strategy for PBDEs for public comment	1st quarter 2009
Formal comment period on the revised Risk Management Strategy for PBDEs	1st and 2nd quarter 2009
Publication of response to comments	3rd quarter 2009

Regulatory controls related to manufactured and imported products containing tetra-, penta-, hexa-, hepta-, octa-, nona- and decaBDE congeners ("PBDE product regulatory controls")

Actions	Date
Publication of a consultation document	4th quarter 2009
Publication of the proposed PBDE product regulatory controls in the *Canada Gazette*, Part I	2010
Formal comment period on the proposed regulatory controls	2010
Publication of the final regulatory controls in the *Canada Gazette*, Part II	2011

DecaBDE Performance Agreement

Actions	Date
Publication of proposed Performance Agreement to address releases of decaBDE from Canadian facilities that use or handle DecaBDE (DecaBDE PA)	1st quarter 2009
Formal comment period on DecaBDE PA	2nd quarter 2009
Publication of final DecaBDE PA	3rd quarter 2009

Addition of tetra-, penta- and hexaBDE congeners to the Virtual Elimination List

Actions	Date
Publication of proposed addition of tetra-, penta- and hexaBDE congeners to Virtual Elimination List in the *Canada Gazette*, Part I	2010
Publication of addition of tetra-, penta- and hexaBDE congeners to Virtual Elimination List in the *Canada Gazette*, Part II	2011

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