Environmental Risk Assessment of Brominated Flame Retardants under the *Canadian Environmental Protection Act, 1999*

Don Gutzman[1], Robert Chénier[1], John Pasternak[2], Lori Suffredine[2] and Ken Taylor[1]

1. Environment Canada, Environmental Protection Service, Gatineau, GC K1A 0H3
2. Environment Canada, Pacific and Yukon Region, 201-401 Burrard St., Vancouver, BC V6C 3S5

Assessments of Chemical Substances Conducted Under the *Canadian Environmental Protection Act, 1999* (CEPA 1999)

CEPA 1999 provides the authority and the requirement to conduct risk assessments of substances in order to determine if they meet the definition of "toxic" as presented in Section 64 of the Act. A substance is "toxic" if it: (a) has or may have an immediate or long-term harmful effect on the environment or its biological diversity; (b) constitutes or may constitute a danger to the environment on which life depends, or (c) constitutes or may constitute a danger in Canada to human life or health. Environment Canada is responsible for conducting assessments pertaining to parts (a) and (b), while Health Canada is responsible for assessments pertaining to part (c).

The Existing Substances Program at Environment Canada relies on a number of pathways, or "feeders" to identify substances as candidates for assessment. These include:

1. Information required to be submitted by industry for substances that they believe may qualify as "toxic" under the definition in CEPA 1999;
2. Emerging science, which provides information that a substance or group of substances may have the potential to harm human health or the environment;
3. Results of international assessments and data collection activities;
4. Concerns associated with different categories of substances based on data received for substances that are new to Canadian commerce;
5. Public nominations of substances of concern;
6. Decisions by a government in Canada or by the government of a foreign state that is a member of the Organization for Economic Co-operation and Development to prohibit or substantially restrict substances;
7. "Categorization" of substances on the Domestic Substances List (DSL) that includes substances in commerce in Canada. Categorization involves consideration of all the approximately 23,000 substances on the DSL to identify those that are: inherently toxic to humans or non-human organisms as well as persistent and/or bioaccumulative in accordance with set criteria; or, pose the greatest potential for human exposure.

Brominated Flame Retardants in Canada

There are about 263 brominated organic substances on Canada's DSL. Twenty-seven of these substances were identified as "flame retardants/fire extinguishing agents" based on their use in 1984-86 and are therefore referred to as brominated flame retardants (BFRs). Given the age of the inventory, it is possible that others of the 263 are now also used as BFRs. BFRs are of particular interest due to the large quantities that are used commercially, and because some members of this group have been detected at increasingly high concentrations as environmental contaminants and in animal tissues. The above-mentioned feeders have proved very effective in identifying a range of BFRs that should undergo assessment.

Categories and Subcategories of Brominated Substances

Brominated substances can be broken down into a number of categories and subcategories. Polybrominated biphenyls (PBB), polybrominated diphenyl ethers (PBDE) and tetrabromobisphenol A (TBBPA) and derivatives belong to the larger category of aromatic compounds based on chemical structure, but for our assessment and regulatory purposes, this broader grouping has been subdivided. These 3 groups of substances have each been used in high quantities and are of concern internationally.

The following categories summarize the brominated substances and BFRs on Canada's DSL. As described, several groups have already been addressed, or are in the process of undergoing assessment. Various other subcategories will undergo assessment in the future.

Polybrominated biphenyls (PBBs) - This category of substances has already been added to the CEPA List of Toxic Substances. Commercial, manufacturing and processing uses of these substances are prohibited in Canada.

Polybrominated diphenyl ethers (PBDEs) - There are strong concerns for this group of substances in Canada and internationally. There are seven PBDEs on the DSL. These seven substances are not used commercially as individual substances, but are components of three commercial products, referred to as pentabromodiphenyl ether, octabromodiphenyl ether and decabromodiphenyl ether. In Canada, an environmental and human health assessment is in the final stages, and is to be released for public comment.

Tetrabromobisphenol A (TBBPA) and derivatives - TBBPA and its derivatives represent the largest commercial BFR group produced globally, with production exceeding 60,000 tonnes annually, corresponding to 40% of the BFR market. In Canada,

TBBPA and two of its derivatives are on the DSL. An environmental and human health assessment is under way and is scheduled for completion in late 2004.

Cycloaliphatic BFRs - There are 23 brominated cycloaliphatic substances on the DSL, six of them identified as BFRs. Hexabromocyclododecane (HBCD) is the cycloaliphatic BFR that is currently attracting most attention internationally. In Canada, four brominated cyclohexanes have been identified as BFRs. Research is being carried out in preparation for an upcoming risk assessment. The dietary accumulation of the various diastereoisomers of HBCD in fish, including the metabolic products and various bioaccumulation parameters, such as rates of uptake and metabolism are being studied.

Aromatic BFRs - There are approximately 180 brominated aromatic substances on the DSL. Six of these have been identified as BFRs**.** Several aromatic BFRs have also been evaluated under the New Substances Program of Environment Canada and Health Canada, and are suspected of being "toxic" as defined by the Act because of their potential to harm the environment. Research is under way in Canada to improve analytical procedures for the determination of various aromatic BFRs in environmental matrices, which will in turn support monitoring initiatives. Several members of this category are being considered for assessment.

Aliphatic BFRs - There are over 50 brominated aliphatic substances on the DSL, five of which are identified as BFRs.

Other Brominated Substances - There are three polymeric substances on the DSL that contain a brominated monomer, which possibly acts as a reactive flame retardant.

Assessments of Brominated Substances

The following table summarizes seventeen brominated substances that are being assessed or will be assessed by Environment Canada and Health Canada over the next few years. Each will be evaluated to determine whether it poses a risk to humans or the environment. Fifteen of these brominated substances have been formally identified on the DSL as being commercially used as flame retardants.

Table - Brominated Substances identified for early assessment

CAS#	Category of Substance	Substance Name
40088-47-9	PBDE	benzene, 1,1-oxybis-, tetrabromo deriv.
32534-81-9	PBDE	benzene, 1,1-oxybis-, pentabromo deriv.
36483-60-0	PBDE	benzene, 1,1-oxybis-, hexabromo deriv.
68928-80-3	PBDE	benzene, 1,1-oxybis-, heptabromo deriv.
32536-52-0	PBDE	benzene, 1,1-oxybis-, octabromo deriv.

63936-56-1	PBDE	benzene, pentabromo(tetrabromophenoxy)-
1163-19-5	PBDE	benzene,1,1-oxybis[2,3,4,5,6-pentabromo-
79-94-7	TBBPA	Phenol, 4,4'-(1-methylethylidene)bis[2,6-dibromo-
25327-89-3	TBBPA-derivative	Benzene, 1,1 -(1-methylethylidene)bis[3,5-dibromo-4-(2-propenyloxy)-
4162-45-2	TBBPA-derivative	Ethanol, 2,2 -[(1-methylethylidene)bis[(2,6-dibromo-4,1-phenylene)oxy]]bis-
3194-55-6	cycloaliphatic	Cyclododecane, 1,2,5,6,9,10-hexabromo-
30554-72-4	cycloaliphatic	Cyclohexane, tetrabromodichloro-
30554-73-5	cycloaliphatic	Cyclohexane, tribromotrichloro-
87-84-3	cycloaliphatic	Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-
608-71-9	Aromatic phenol	Phenol, pentabromo-
32588-76-4	Aromatic imide	1H-Isoindole-1,3(2H)-dione, 2,2'-(1,2-ethanediyl)bis[4,5,6,7-tetrabromo-
37853-59-1	Aromatic ether	Benzene, 1,1'-[1,2-ethanediylbis(oxy)]bis[2,4,6-tribromo-

Looking to the future

The other brominated substances on the DSL, including BFRs, are currently being categorized to determine whether they will be required to undergo assessment in the future. CEPA 1999 requires that the results of Canada's categorization exercise be published by November 2006.

Through our "feeders", and by discussion with both Canadian and international BFR experts, Environment Canada is interested in prioritizing its assessments, and identifying other BFRs that should undergo evaluation.