5 February 2008

Response to additional information on c-OctaBDE

The Bromine Science and Environmental Forum (BSEF, www.bsef.com) is the global representative of the bromine industry. Its members are the world's largest manufacturers of brominated flame retardants used mainly as plastic additives and in coatings for textiles to improve the fire safety of these products.

BSEF would like to provide the following information and comments in response to the request for comments by the Secretariat to the Stockholm Convention on the proposal to list commercial Octabromodiphenyl Ether (c-OctaBDE) concerning:

I/ Information on octa-BDE and nona-BDE related to risk estimation and bioaccumulation

Comment [b1]: Did we decide not to send anything? In that case we can erase

Nothing new to report on this section. We again refer the POPRC to the EU risk assessment on c-OctaBDE where it is acknowledged that BDE molecules with 7 or more bromine atoms are not expected to bioaccumulate, particularly not to the extent of those having 4-6 Bromine atoms.

II/ Information on quantitative assessments of the role of debromination

In adopting the Risk Profile of c-OctaBDE qualitative studies were presented but their relevance and scientific accuracy is questionable.

More specifically:

- ***Reductive debromination should not be a consideration in evaluating the POP characteristic of c-OctaBDE or in the development of the Risk Management Evaluation due to lack of scientific evidence.***

The Risk Profile (RP) maintains that a number of studies suggest that Br8 and Br9 isomers are capable of metabolic debromination and could lead to the formation of lower POP isomers in natural conditions.

However, current science and the studies referenced in the Risk Profile (please see *References*) fall short on evidence that significant degradation of higher to lower brominated diphenyl ether congeners is actually occurring in the environment or in wildlife. Even if this is a possible occurrence, the extent of its impact on total exposure to lower BDEs (those with Br4-6) for humans or the environment remains unclear, but is likely to be insignificant based on a recent assessment published by the European Union (EU).

- ***The metabolic and other debromination studies quoted have not utilised c-OctaBDE and their relevance has not adequately been demonstrated***

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Scientific evidence related to debromination of Octa and Nona-BDE into lower BDEs was not presented. Studies that were carried out using PBDEs that were not c-OctaBDE were extrapolated to c-OctaBDE but this remains only speculation and is not supported by the available work to date or in the information provided in the Risk Profile.

- ***The actual impact of debromination is not proven***

Although researchers have shown that metabolism of certain PBDEs can happen, only a small fraction of the external exposure is taken up and only a small fraction of the internal exposure is transformed. For instance, in the study of Stapleton et al 2006, a total amount of 0.06% of the dose was taken up. Considering that the methods used to expose the animals greatly exaggerated the external levels and uptake fraction that would occur in the environment, the contribution to total internal levels of lower BDEs cannot be determined. It is therefore questioned how much of an impact this process has on total exposure for humans or the environment. *Please find the relevant excerpts from the EU Risk Assessment Report in the Annex I of this document.*

Moreover, monitoring studies show that the particular lower BDEs reported in metabolism studies (such as Stapleton et al. 2006) are not what we see in real fish from the environment. This indicates that this process can happen in the laboratory, but its environmental relevance is low, otherwise we would observe these substances in nature.

Another piece of evidence that needs to be considered is the fact that a main mechanism of debromination seems to be via p-debromination (Stapleton et al 2006, Huwe et al). This means that the BDEs formed by that process cannot be those found in the environment since the environmental BDEs are all brominated at the p-position. Again, this demonstrates that the environmental relevance of this process is low.

In addition to the assessment made above on the qualitative studies on the possible degradation of higher PBDEs to Hexa or Hepta congeners present in c-Octa BDE and for which POPs characteristics have been identified, BSEF is not aware of any quantitative data on debromination. Therefore, even if the proof provided by the qualitative studies is considered as correct, we are not aware of any proof that it may happen to any significant extent.

Consequently, due to the lack of conclusive evidence presented it is suggested to re-visit the Risk Profile at POPRC 4.

III/ Toxicological and ecotoxicological information for the commercial mixture and its components

All available industry-funded studies on toxicological and ecotoxicological assessment of the commercial mixture are being gathered to send to the drafters of the Risk Management Evaluation. These will be available in the next few weeks.

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BSEF will be happy to share copies of the studies with the Secretariat or other Parties and observers if requested. *Please see an indicative list of these studies in Annex II.*

References

Alonso E, Tapie N, Budzinski H, Tarazona, JV 2006. Calibration of biomagnification model. Kinetic Behaviour Of Several Compounds In Mytilus edulis and Sparus aurata After Oral Exposure. LRI Programme Environment: persistence, bioaccumulation & toxicity. Project No: ECO-1AINIA-1100. Milestone Report.

Drouillard KG, Fernie KJ, Letcher RJ., Shutt LJ., Whitehead M, Gebink W and Bird DM, 2007. Bioaccumulation and biotransformation of 61 polychlorinated biphenyl and four polybrominated diphenyl ether congeners in juvenile American kestrels (*Falco sparverius*). Environ. Toxicol. Chem. 26:313–324.

European Community. Update of the Risk Assessment of Bis(pentabromophenyl)ether (Decabromodiphenyl Ether). October 2007.

Kierkegaard A, Asplund L, de Wit CA, McLachlan MS, Thomas GO, Sweetman AJ, Jones KC, 2007. Fate of higher brominated PBDEs in lactating cows. Environ Sci Technol. 41:417-23.

Stapleton HM, Baker JE, 2003. Debromination of BDE congeners by the common carp (Cyprinus carpio). 5th Annual Workshop on Brominated Flame Retardants in the Environment, August 22–23, Boston, MA.

Stapleton HM, Brazil B, Holbrook RD, Mitchelmore CL, Benedict R, Konstantinov A, Potter D, 2006. *In vivo* and *in vitro* debromination of decabromodiphenyl ether (BDE 209) by juvenile rainbow trout and common carp. Environ Sci Technol. 40:4653-8.

Tomy GT, Palace VP, Halldorson T, Braekevelt E, Danell R, Wautier K, Evans B, Brinkworth L, Fisk AT, 2004. Bioaccumulation, biotransformation, and biochemical effects of brominated diphenyl ethers in juvenile lake trout (Salvelinus namaycush). Environ Sci Technol. 38:1496-504.

Van den Steen E, Covaci A, Jaspers VL, Dauwe T, Voorspoels S, Eens M, Pinxten R, 2007. Accumulation, tissue-specific distribution and debromination of decabromodiphenyl ether (BDE 209) in European starlings (*Sturnus vulgaris*). Environ Pollut. 148:648-653.

ANNEX I

Excerpts from the 2007 update of the EU Risk Assessment Report on Deca BDE:

- Regarding the Kierkegaard et al. (2007) study (page 120):

"Kierkegaard et al. (2007) also investigated the congener profile present in the various samples for evidence for possible biotransformation of decabromodiphenyl ether to lower brominated congeners. This analysis suggested that four congeners (2,2',3,3',4,4',5,6,6' nonabromodiphenyl ether, 2,2',3,3',4,4',5,6'-octabromodiphenyl ether, 2,2',3,3',4,4',6,6'-octabromodiphenyl ether and possibly 2,2',3,4,4',5,6'-heptabromodiphenyl ether) were present in lipids at higher concentrations than might be expected based on their concentration in the feed. Several possibilities were put forward by the authors to explain this, including differences in dietary absorption between congeners or biotransformation in the digestive system. Other possibilities such as photochemical degradation of decabromodiphenyl ether during sample handling and debromination occurring in the rumen were ruled out because all samples were stored in the dark and degradation during sampling/analysis was accounted for in the analytical approach used and no differences were seen in the congener profiles between faeces and feed (a difference would be expected if debromination in the rumen was occurring)."

The actual explanation for the results was not clear. However, in terms of the PBT assessment both of these possible explanations are relevant. For example, if the findings are explained by differences in dietary absorption, this would imply that the some of the nonabrominated diphenyl ether congeners (particularly 2,2',3,3',4,4',5,6,6'-nonabromodiphenyl ether) have a higher potential for bioaccumulation than decabromodiphenyl ether itself. Similarly if the findings are explained by biotransformation of decabromodiphenyl ether, then it would be necessary to consider the formation of these congeners when evaluating the bioaccumulation potential of decabromodiphenyl ether itself, i.e. it would be most relevant to consider the "total" concentration (i.e. decabromodiphenyl ether plus persistent metabolites) in the organism resulting from an exposure to decabromodiphenyl ether when determining the accumulation factor for decabromodiphenyl ether."

- Regarding the Stapleton et al. (2006) study (page 107):

"Overall, the results of Stapleton et al. (2006) provide convincing evidence that decabromodiphenyl ether was being metabolised in the fish to form lower brominated diphenyl ether congeners. This was shown conclusively in the in vitro experiments with

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both trout liver and carp liver extracts, and a very similar pattern of metabolism was also evident in the in vivo experiments. The initial steps in the metabolism appear to occur preferentially, but not exclusively, via debromination in the para- position. Of particular relevance is the fact that various hexabromodiphenyl ether congeners appear to be formed. These congeners are known to be much more bioaccumulative than decabromodiphenyl ether (e.g. see EC (2001) and EC (2003)) and this aspect is considered later in relation to the PBT assessment for decabromodiphenyl ether in Section 8. The amounts of hexabromodiphenyl ethers formed in the in vivo experiments with rainbow trout do appear to be relatively small (<2% of the total polybrominated diphenyl ethers present after 112 days; as the trout assimilated around 3.2% of the dose at this time, this amounts to around <0.064% of the applied dose)."

Additional considerations:

"An important consideration for this substance is its potential to form lower PBDE congeners (and brominated dibenzofurans, etc.) in the environment. Some of these are considered to be PBT or vPvB substances. As pointed out in Section 6.1.2, there is an indication (from a feeding study with cows) that nonabromodiphenyl ether congeners may be more accumulative than decabromodiphenyl ether.

Many studies have now shown that debromination can occur under a range of conditions in the laboratory (e.g. anaerobic biodegradation, photolysis, reaction with minerals, etc.), as summarised in detail in Section 5. In particular, photolytic debromination has been shown to occur when the substance is present in dust exposed to sunlight, although the annual release of the substance adhered to dust particles is unclear (one study suggests that losses across the EU from textiles in service are ~ 1 tonne/year – see Section 3.1.2). Given the substance's persistence and ubiquity, there remains a chance that PBT/vPvB substances will be formed in some situations (e.g. where more significant exposure to light could occur, such as on windows, or where significant amounts of reductants occur).

However, the laboratory results are generally difficult to extrapolate to environmentally relevant conditions. In particular, it is not possible to estimate the rate of formation and degradation of these products based on the available data, although several studies suggest that the reaction will be very slow. This appears to be borne out by the few studies that have used more realistic conditions (e.g. the sediment simulation test reported in EC (2002) failed to detect any degradation over a 32-week period). Similarly, there is little evidence for such degradation under field conditions. For example, the study of Sellström *et al*. (2005) found no indications for degradation in field soils over an extended period of time. Some studies suggest that a large range of congeners will be formed, but such a pattern is not usually seen in environmental samples (although this may because researchers have not looked for them consistently). The conclusion (i) programme has used a specific pentabromodiphenyl ether congener (BDE-126) as a potential marker of abiotic degradation and this has not been detected in any of the samples to date.

In addition, many laboratory studies showing that debromination can occur do not actually demonstrate the formation of PBT/vPvB substances. The overall significance of these processes in the environment therefore remains unknown.

Recent laboratory work has clearly shown that vertebrates (e.g. fish) can metabolise decabromodiphenyl ether to lower PBDE congeners, with typically nona- to hepta- or hexabromodiphenyl ethers being found (some of which are considered to be vPvB substances) (see Section 6.1.2). Given that decabromodiphenyl ether is present in a wide range of aquatic (including fish) and terrestrial species in the environment, it is probable that such metabolism is occurring in organisms in the environment. However, the rate of metabolism appears to be low (e.g. in one study, the hexaBDE congeners formed were <0.1% of the applied dose of parent substance over 112 days).

The major products of metabolic processes in mammals are generally substances that are more water soluble and more readily excreted. Once again, the studies tend to be over short periods, and no work has been done on lifetime exposures.

A recent study with birds (European starlings; see Section 6.1.2) has provided some evidence for metabolism to lower brominated congeners following implantation of a solution of decabromodiphenyl ether. Again the main metabolites found were thought to be nona- and octabromodiphenyl ethers, which themselves are not PBT or vPvB substances. The method of administration used in this study means that it is not possible to use these data to estimate the amounts of metabolites that may be formed in the environment.

As discussed in Section 4.6, there is some (albeit limited) evidence from the available monitoring data for the formation of lower brominated congeners from the metabolism of decabromodiphenyl ether in wild fish.

In summary, it is not possible to estimate the amounts of PBT/vPvB degradation products that may be formed in the environment over any particular timescale based on the available data. It is possible that the concentration of “total” polybrominated diphenyl ethers arising from exposure to the commercial substance (including impurities and metabolites) may be higher than expected based on the measurements of decabromodiphenyl ether alone. This may need to be taken into account in any further regulatory activity (e.g. monitoring).”

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ANNEX II

Partial list of Industry funded studies being prepared for submission to drafters as additional information for the toxicological and eco-toxicological information for the commercial mixture and its components

Great Lakes Chemical Corporation, West Lafayette, IN (1975a). Toxicity data on OBDPO (DE-79). Acute dermal toxicity in Albino rabbits. Unpublished Laboratory Report, Intl. Res. & Dev. Corp.

Great Lakes Chemical Corporation (1975b). Toxicity data on OBDPO. Acute Inhalation Toxicity in the Albino rat.Unpublished Laboratory Report, Intl. Res. & Dev. Corp; Great Lakes Chem. Corp.

Great Lakes Chemical Corporation (1975c). Toxicity data on OBDPO (Saytex 111). Primary skin irritation in Albino rabbits. Unpublished Laboratory Report, Intl. Res. & Dev. Corp. Great Lakes Chem. Corp.

Great Lakes Chemical Corporation (1975d). Toxicity data on OBDPO. Eye irritation in Albino rabbits. Unpublished Laboratory Report, Intl. Res. & Dev. Corp.

Great Lakes Chemical Corporation, West Lafayette, IN. (1976a). Toxicity data on OBDPO (DE-79). Twenty-eight day toxicity study in rats. Unpublished Laboratory Report, Intl. Res. & Dev. Corp.

Great Lakes Chemical Corporation, West Lafayette, IN (1976b). Toxicity data on OBDPO (DE-79). Mutagenicity evaluation of compound 345-79A. Final Report. Unpublished Laboratory Report, Litton Bionetics.

Great Lakes Chemical Corporation, West Lafayette, IN (1977). Toxicity data on OBDPO (DE-79). Thirteen week feeding study in rats. Unpublished Laboratory Report, Intl. Res. & Dev. Corp.

Great Lakes Chemical Corporation, West Lafayette, IN (1978). Toxicity data on OBDPO (DE-79). Subacute Inhalation Toxicity study in rats. Unpublished Laboratory Report, Intl. Res. & Dev. Corp.

Great Lakes Chemical Corporation, West Lafayette, IN (1982). Toxicity data on OBDPO (DE-79). In vitro sister chromatid exchange in Chinese Hamster Ovary Cells with OBDPO (DE-79). Final Report. Unpublished Laboratory Report, Hazleton Laboratories.

Great Lakes Chemical Corporation, West Lafayette, IN (1983). Toxicity data on OBDPO (DE-79). Unscheduled DNA synthesis assay compound DE-79. Final Report. Unpublished Laboratory Report, Hazleton Laboratories.

Great Lakes Chemical Corporation, West Lafayette, IN (1986). Toxicity data on OBDPO (DE-79). A Range-Finding teratology study in rats with DE-79. Final report. Unpublished Laboratory Report, Wil. Research Laboratories, Inc.

Great Lakes Chemical Corporation, West Lafayette, IN (1987). Toxicity data on OBDPO (DE-79). Acute Oral Toxicity in the male Albino Rat. Unpublished Laboratory Report, Intl. Res. & Dev. Corp. (*Note - This is a citation error, it really should be cited as "1975e" as it is part of the same report as 1975a-d)*

Great Lakes Chemical Corporation, West Lafayette, IN (1999). Toxicity data on OBDPO. In vitro mammalian chromosome aberration test. Final report. Unpublished laboratory report, BioReliance.

Great Lakes Chemical Corporation, West Lafayette, IN (2000). A 2-week inhalation toxicity range-finding study of octabromodiphenyl oxide in albino rats. Unpublished laboratory report, WIL Research Laboratories, Inc.

Great Lakes Chemical Corporation, West Lafayette, IN (2001b). A 90 day inhalation toxicity study of octabromodiphenyl oxide in albino rats. Unpublished laboratory report, WIL Research Laboratories, Inc.

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