Alternatives to Deca-BDE in Televisions and Computers and Residential Upholstered Furniture

Implementation of RCW 70.76: Identifying safer and technically feasible alternatives to the flame retardant called Deca-BDE used in the electronic enclosures of televisions and computers and in residential upholstered furniture

Final Report

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Final Report

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Executive Summary

This report fulfills the requirements of RCW 70.76, signed into law by Governor Gregoire in 2007. This law restricts the manufacture, sale and distribution of products containing a type of chemical flame retardant called PBDEs (polybrominated diphenyl ethers). The three types of PBDEs used in consumer products are Penta-BDE, Octa-BDE and Deca-BDE. The prohibition became effective for all products containing Penta-BDE and Octa-BDE, and for mattresses containing Deca-BDE in January, 2008. At the time the law was passed, safer alternatives for Deca-BDE had not been identified for other products, specifically, residential upholstered furniture, and electronic enclosures used in televisions and computers. RCW 70.76 lays out a process for identifying the availability of safer, technically feasible alternatives to Deca-BDE that meet fire safety standards for these applications. When safer alternatives are identified, the manufacture, sale or distribution of upholstery and electronic enclosures containing Deca-BDE will be prohibited two years from the date of identification.

As required by RCW 70.76, the Departments of Ecology (Ecology) and Health (DOH) reviewed risk assessments, scientific studies, and other relevant findings regarding alternatives to the use of Deca-BDE in residential upholstered furniture, televisions, and computers.

The agencies identified a safer, technically feasible alternative chemical flame retardant for TVs and computers. Non-chemical alternatives were identified for upholstered furniture. These alternatives were presented to a committee of fire safety experts appointed by the governor to determine if they can provide appropriate fire retardant capacity. The Fire Safety Committee met on November 7, 2008 and found that the identified alternatives meet applicable fire safety standards. The Fire Safety Committee reported its findings to the Office of the State Fire Marshal who, on November 18, 2008, determined that the identified alternatives meet applicable fire safety standards.

Ecology posted the draft report on its web page and notified the public and stakeholders about its availability. Public comment was accepted from November 20 until December 17, 2008. A notice was placed in the State Register on December 3, 2008 as well. A response to these comments in included in Appendix 6.

Alternatives Assessment Approach

RCW 70.76 requires that Ecology and DOH review risk assessments, scientific studies and other relevant findings to determine if a safer and technically feasible alternative to Deca-BDE is available. The statute requires that the agencies assure that at least one safer alternative is available. The agencies interpret “safer and technically feasible” as including:

- A chemical alternative to Deca-BDE that is less toxic, less persistent or less bioaccumulative than Deca-BDE, and that is currently being used in products, or

- A technology, material or other design strategy, currently in use and reasonably available, that provides fire safety for televisions, computers or upholstered furniture without the addition of chemical flame retardants. For example, while some electronic enclosures achieve fire protection through the use of metal instead of plastic, Ecology believes that requiring redesign to this extent may go beyond the definition of "feasibility" in the statute.

The agencies did not evaluate every option and therefore this report makes no assertion as to the relative safety of flame retardants or technologies we did not evaluate. Ecology and DOH do not have the regulatory authority to dictate what method furniture manufacturers select to maintain fire safety.

The statute does not require that the identified safer alternative be a direct substitute for Deca-BDE but does require that the alternative be “technically feasible”. Ecology determined that a good indicator of technical feasibility is the presence and reasonable availability of the product on the market using the alternative. For example, if Ecology demonstrates that currently available computers are employing the identified alternative to Deca-BDE, then that alternative is considered technically feasible.

Electronic Enclosures for TVs and Computers

There are many available chemical flame retardants that can be used to provide fire safety for televisions and computers. In evaluating alternatives to the use of Deca-BDE in electronic enclosures, Ecology and DOH focused on non-halogenated flame retardants which are less likely to persist in the environment and to bioaccumulate in organisms. Non-halogenated alternatives also have the added benefit of being much more easily degraded than their halogen equivalents, thereby reducing their potential long-term impact on human health and the environment.

Technical feasibility was evaluated using indirect information because manufacturers do not generally reveal which chemicals are actually being used to provide fire safety in their electronic products. Ecology looked first to Europe, where Deca-BDE has been banned in electronic products since July, 2008. Ecology assumed that if these products can be made cost effectively and sold in Europe they can be made cost effectively and sold in the U.S. as well. Several European studies demonstrate that resorcinol bis(diphenyl phosphate) (RDP) has been used in electronic enclosures for televisions and computers sold in Europe. Also, the computer industry has largely moved away from use of halogenated flame retardants. Ecology and DOH did not identify technically feasible design options for televisions and computers that do not require the use of added flame retardants so these alternatives were not considered feasible.

After reviewing recent studies, reports and other information, most of which became available after the PBDE Chemical Action Plan was completed, Ecology and DOH identified two possible phosphate-based flame retardants: resorcinol bis diphenyl phosphate (RDP) and triphenyl phosphate (TPP), as technically feasible alternatives.

The agencies then conducted a review of information available on these two flame retardants to determine if both could be recommended as safer alternatives to Deca-BDE. This review included a comparison of toxic effects levels observed in animal studies and an evaluation of aquatic toxicity information.
Based upon this evaluation, the agencies found that RDP is a safer and technically feasible alternative to Deca-BDE. TPP was eliminated due to concerns related to its aquatic toxicity.

Plastics used in electronic products are rated for their flame retardation capacity using a voluntary standard identified by the National Fire Protection Association (NFPA) in conjunction with the Underwriters Laboratory (UL), which defines the specific method. The agencies presented information to the Fire Safety Committee on the performance of RDP compared with Deca-BDE when used in electronic enclosures. RDP performs as well as Deca-BDE, although a different type of plastic has to be used. As required by RCW 70.76, the Fire Safety Committee voted on whether or not RDP provides appropriate fire protection. The committee unanimously found that RDP meets applicable fire safety standards.

FINDING
A safer, technically feasible alternative to Deca-BDE, which meets applicable fire safety standards, is available for use in televisions and computers.

Residential Upholstered Furniture

For residential upholstered furniture, Ecology and DOH relied on information from the Consumer Product Safety Commission (CPSC) about the current use of Deca-BDE in furniture sold in the U.S. and the availability of furniture design options that do not require the addition of chemical flame retardants. Ecology and DOH decided to focus on design alternatives that use inherently flame resistant materials, rather than evaluate options that use added chemical flame retardants. Since there are currently available design options that can be used to achieve fire safety, the agencies focused on these instead of evaluating the safety of other chemical flame retardants that could be used to comply with the proposed standards.

The CPSC recently published a proposed flammability standard for residential upholstered furniture. Under the CPSC's proposed standard, fire safety in upholstered furniture can be achieved through the use of compliant cover materials (fabrics) or internal barrier layers. The proposed standard does not rely on the addition of chemical flame retardants, such as Deca-BDE, for compliance although flame retardants could be used. If the proposed standard is finalized as such, furniture manufacturers will have the option to meet fire safety requirements through several currently available design options that use inherently flame resistant cover fabrics or internal barriers. For example, many existing cover materials, especially those made from synthetic fibers, can meet the proposed standard without the addition of chemical flame retardants.

Furniture manufacturers could also comply with the CPSC proposed standard by using internal barrier materials, some of which may require the addition of chemical flame retardants. Inherently flame retardant barrier technologies that do not require the addition of chemical flame

retardants are available similar to those currently being used to achieve fire safety in mattresses. The CPSC estimates that the use of barrier materials in general as a method to comply with these standards is not a popular choice among manufacturers and would likely be used in only about 5 percent of upholstered furniture. Chemical flame retardants are most likely to be used in internal barriers under the CPSC proposed standard, but they are not expected to be widely used because many cover fabrics will comply. Although the CPSC flammability standard for residential furniture has not been finalized, it is expected that design options will be available to meet any additional requirements in a final standard.

California is the only state that currently has a flammability standard for residential upholstered furniture and Deca-BDE has not been used to meet this standard. According to CPSC staff, Deca-BDE is currently not being used by furniture manufacturers to comply with the California standards nor would it be used to comply with the proposed CPSC standards. Therefore, any ban on the use of Deca-BDE for this purpose in Washington would not impose new costs or require manufacturers to retool their processes or redesign their products in order to comply with this prohibition.

Based on furniture design options that are already available, the agencies concluded that the safer, technically feasible alternative to Deca-BDE in residential furniture is non-chemical design options. The Fire Safety Committee voted on whether or not these non-chemical design changes can provide appropriate flame retardation. The committee unanimously found that non-chemical alternatives meet the proposed federal CPSC fire safety standards for residential upholstered furniture.

FINDING
Safer, technically feasible alternatives to the use of Deca-BDE, which meet the current and proposed applicable fire safety standards, are available for use in residential upholstered furniture.

CONCLUSIONS

Safer, technically feasible alternatives to the use of Deca-BDE in TVs, computers and residential upholstered furniture are available and meet applicable fire safety standards. The restrictions on the use of Deca-BDE in these products as defined by RCW 70.76 will take effect on January 1, 2011.

Acronyms and Abbreviations

BAPP	Bisphenol A bis(diphenyl phosphate) (aka BDP)
BDP	Bisphenol A bis(diphenyl phosphate) (aka BAPP)
CAP	chemical action plan
CAS Nr.	Chemical Abstract Services Number
CPSC	U.S. Consumer Product Safety Commission
Deca-BDE	Decabrominated diphenyl ether commercial mixture
deca-BDE	decabrominated diphenyl ether specific congener
DOH	Washington Department of Health
Ecology	Washington Department of Ecology
Green Screen	The Green Screen For Safer Chemicals methodology from Clean Production Action
HIPS	high impact polystyrene
Octa-BDE	Octabrominated diphenyl ether commercial mixture
PBDE	polybrominated diphenyl ether
PC/ABS	polycarbonate/acrylonitrile/butadience/styrene blend
Penta-BDE	Pentabrominated diphenyl ether commercial mixture
PPO	polyphenylene oxide
RCW	Revised Code of Washington
RDP	resorcinol bis(diphenyl phosphate)
TPP	triphenyl phoshate

I. Introduction

This report on Alternatives to Deca-BDE[1] in Electronics Enclosures and Residential Upholstered Furniture is a joint document of the Washington State Department of Ecology (Ecology) and Department of Health (DOH). This report was written to fulfill the requirements of RCW 70.76, signed into law by Governor Gregoire in 2007. RCW 70.76 lays out a process for identifying the availability of safer, technically feasible alternatives to Deca-BDE that meet fire safety standards for televisions, computers and residential upholstered furniture. If alternatives are identified, the sale or distribution of products containing Deca-BDE for which there is an alternative will be prohibited two years from the date of identification. RCW 70.76.030(2) describes the requirements for this report:

(a) The department and the department of health shall review risk assessments, scientific studies, and other relevant findings regarding alternatives to the use of commercial deca-bde in residential upholstered furniture, televisions, and computers.

(b) If the department and the department of health jointly find that safer and technically feasible alternatives are available for any of these uses, the department shall convene the fire safety committee created in RCW 70.76.040 to determine whether the identified alternatives meet applicable fire safety standards.

(c) By majority vote, the fire safety committee created in RCW 70.76.040 shall make a finding whether an alternative identified under (b) of this subsection meets applicable fire safety standards. The fire safety committee shall report their finding to the state fire marshal. After reviewing the finding of the fire safety committee, the state fire marshal shall determine whether an alternative identified under (b) of this subsection meets applicable fire safety standards. The determination of the fire marshal must be based upon the finding of the fire safety committee. The state fire marshal shall report the determination to the department.

(d) The department shall seek public input on their findings, the findings of the fire safety committee, and the determination by the state fire marshal. The department shall publish these findings in the Washington State Register, and submit them in a report to the appropriate committees of the legislature. The department shall initially report these findings by December 31, 2008.

Ecology and DOH completed a Chemical Action Plan (CAP) for PBDE flame retardants in 2005. The CAP established the need to phase out the use of Deca-BDE, particularly in products used in the household environment where the majority of exposure to these chemicals occurs. However, at that time, there was not sufficient evidence that less toxic alternatives to Deca-BDE were available for furniture and electronic enclosures. Indeed, there are four other chemical flame retardants on Ecology's list of Persistent, Bioaccumulative, Toxic chemicals (PBTs) which would, by definition, be undesirable as substitutes for Deca-BDE. The drafters of RCW 70.76 considered this and delayed the prohibition on Deca-BDE until Ecology and DOH could identify at least one safer alternative and report those findings to the legislature.

[1] For the purposes of this report, the term 'Deca-BDE' refers to both the commercial flame retardant mixture that consists of approximately 97 percent of the deca-BDE congener and 3 percent nona- and octa-BDE congeners and the deca-BDE congener alone. For a more complete description of these terms see the PBDE Chemical Action Plan, Department of Ecology, 2005. Publication No. 05-07-048.

Ecology and Health reviewed recent risk assessments, scientific studies and other relevant findings, most of which were not available when the PBDE CAP was completed, regarding alternatives to the use of the flame retardant Deca-BDE in residential upholstered furniture and television and computer electronic enclosures. This report provides the results of that review.

Ecology and DOH identified a safer, technically feasible alternative chemical flame retardant for TVs and computers. Non-chemical alternatives were identified for upholstered furniture. These alternatives were presented to a committee of fire safety experts appointed by the governor to determine if these alternatives can provide appropriate flame retardant capability. The Fire Safety Committee met on November 7, 2008 and found that the alternatives identified by Ecology and DOH meet applicable fire safety standards. The Washington State Fire Marshal agreed with these findings on November 18, 2008.

Ecology sought public input on this finding. The public was invited to comment from November 20 until December 17, 2008. A notice was placed in the State Register on December 3, 2008. Comments received and the agencies responses can be found in Appendix 6. The comment letters are included in Appendix 7.

Identifying Safer Alternatives

In determining how best to identify safer alternatives to Deca-BDE, the agencies found that Deca-BDE could be replaced in one of three ways:

1. An alternative flame retardant can be used. This approach assumes that no design changes or retooling would be necessary and a straight substitution of an alternative for Deca-BDE could be made.

2. A different type of material (such as plastic or foam) using an alternative chemical flame retardant can be substituted for the existing product. This approach likely involves some design changes and may require retooling.

3. The product can be redesigned so that the addition of chemical flame retardants is no longer needed to provide fire safety.

In evaluating alternatives for electronic enclosures, Ecology and DOH focused on options for using different types of plastics so that non-halogenated flame retardants could be considered. Because non-halogenated flame retardants are less likely to persist in the environment and to bioaccumulate in organisms, Ecology and DOH decided upfront to avoid alternatives that contain halogens. The use of non-halogenated flame retardants in electronic enclosures requires a change in plastic from high impact polystyrene (HIPS), which is the plastic historically used with Deca-BDE.

For residential upholstered furniture, Ecology and DOH relied on information from the Consumer Product Safety Commission (CPSC) about the current use of Deca-BDE in furniture sold in the U.S and availability of furniture design options that do not require the addition of chemical flame retardants. Ecology and DOH decided to focus on alternatives that use

inherently flame resistant materials, rather that relying upon added chemical flame retardants as the most desirable way to achieve fire safety while minimizing the use of harmful toxic chemicals.

Ecology and DOH considered only those chemicals or technologies currently on the market and available to replace Deca-BDE in current products, while still maintaining fire protection.

This report utilizes the information provided in the PBDE Chemical Action Plan (CAP) and updates the conclusion reached in the CAP by evaluating information that has become available since the CAP's completion. The new sources of information include the following:

- Maine DEP and Maine CDC, 2007
- Illinois EPA, 2007
- Danish EPA, 2007 & European Commission, 2007
- Clean Production Action, 2007
- Karlsruhe Research Center, 2007
- EPA IRIS File for bde-209, 2008
- Troitzsch, Jürgen, 2007, 'Commercially Available Halogen free Alternatives to Halogen-Containing Flame Retardant Systems in Polymers'

Additional information on each of these sources is provided later in this report.

The purpose of this review is to determine if these additional studies on Deca-BDE and its alternatives is sufficient to change the conclusion of the original alternatives assessment in the CAP, i.e. that no viable alternative to Deca-BDE could be identified.

For electronic enclosures, the agencies reviewed information on alternatives provided in assessment reports published since the CAP was completed. These reports included analyses of the toxicity, persistence, and bioaccumulation potential for a variety of flame retardants as well as information on the feasibility of different alternatives. A summary of the assessment reports reviewed by Ecology and DOH for this report is presented in Appendix 1. As noted above, Ecology and DOH limited the review of alternatives flame retardants to non-halogenated flame retardants.

Based on the review of reports and other information, Ecology and DOH narrowed the focus of the evaluation to two possible phosphate-based flame retardants for final consideration: RDP and TPP. A comparison of toxic effects levels observed in animal studies and a review of aquatic toxicity information are presented in Appendix 2. Ecology also estimated potential environmental releases of phosphate associated with the use of phosphate flame retardants to address questions about how these products might contribute to water quality phosphate loading levels. The assumptions and methods used for this calculation are presented in Appendix 3.

For alternatives in residential upholstered furniture, the agencies relied on CPSC's new proposed flammability standard for these products and related information from CPSC and others. This review indicates that there are design options available that can be used in place of Deca-BDE or other flame retardants to meet flammability standards for residential upholstered furniture.

These design options are similar to methods being used currently by manufacturers to comply with the mattress flammability standard that went into effect in 2007.

Based upon the review of this additional information and a more detailed evaluation of the impacts alternatives to Deca-BDE have upon human health and the environment, Ecology and DOH determined that safer alternatives exist for Deca-BDE used in plastics in electronic enclosures and in residential upholstered furniture.

II. Requirements of RCW 70.76 (PBDE legislation)

In 2007, Governor Christine Gregoire signed ESHB 1024 into law, placing restrictions on the sale of products containing PBDEs in Washington State. House Bill 1024 created Chapter 70, Section 76 of the Revised Code of Washington (RCW), which details the provisions of the restrictions.

RCW 70.76 prohibits the manufacture, sale, or distribution of products containing PBDEs with the exception of products containing Deca-BDE. Other exemptions include:

- Vehicles and vehicle parts
- Products used in military and federally funded space program applications
- Fire safety equipment used in airplanes
- The sale of used products
- New products made from recycled material containing Deca-BDE
- Carpet cushion made from recycled foam containing less than one-tenth of one percent Penta-BDE
- Medical devices

Of products containing Deca-BDE, the manufacture, sale or distribution of three categories of consumer products are restricted by RCW 70.76.030:

1.) Mattresses
2.) Residential upholstered furniture
3.) Televisions or computers with Deca-BDE in the electronic enclosure

The manufacture, sale or distribution of mattresses containing Deca-BDE was prohibited as of January 1, 2008. Restrictions on the sale of upholstered furniture and televisions or computers are subject to the identification of available safer and technically feasible alternatives that meet applicable fire safety standards.

To identify available safer and technically feasible alternatives, RCW 70.76 requires that Ecology and DOH review risk assessments, scientific studies, and other relevant findings regarding alternatives to the use of Deca-BDE in residential upholstered furniture, televisions, and computers. This report is written to satisfy that requirement.

RCW 70.76 requires that, if the Ecology and DOH jointly find that safer and technically feasible alternatives are available for these uses, Ecology must convene a Fire Safety Committee comprised of the following members:

1. A representative of Ecology, to chair the committee and act as an ex officio member
2. Five voting members, appointed by the governor, representing:
    a. The Office of the State Fire Marshal
    b. A statewide association representing the interests of fire chiefs
    c. A statewide association representing the interests of fire commissioners

d. A recognized statewide council affiliated with an international association representing the interests of firefighters
e. A statewide association representing the interests of volunteer firefighters

RCW 70.76 requires that the Fire Safety Committee determine, by simple majority vote, whether the alternatives identified by Ecology and DOH meet applicable fire safety standards. The State Fire Marshal then makes a determination based on the finding of the Fire Safety Committee as to whether the alternatives proposed meet applicable fire safety standards (See Appendix 5).

Ecology is required to initially report its and DOH's findings, the findings of the Fire Safety Committee, and the determination by the State Fire Marshall in the Washington State Register and to appropriate committees of the legislature by December 31, 2008. If safer and technically feasible alternative that meets fire safety standards is available, the manufacture, sale or distribution of products containing Deca-BDE is prohibited as of January 1, 2011.

If the initial report finds that no safer, technically feasible alternative that meets fire safety standards is available, no prohibition will take effect. Instead, by December 31 of each successive year, Ecology and DOH may report on alternatives, using the process described above. When a safer, technically feasible alternative that meets fire safety standards is identified, a prohibition on the sale or distribution of products containing Deca-BDE for which there is an alternative takes effect two years after a report is submitted to the legislature.

This report does not satisfy the requirements of RCW 70.76.050. This section of the statute requires Ecology and DOH to continue to review new scientific information on alternatives to Deca-BDE for other products (i.e. other than TVs, computers and furniture) as well as the potential effect of PBDEs in the waste stream. Findings that result from this work must be reported to the legislature but do not trigger any further prohibition on the sale, manufacture or distribution of other Deca-BDE containing products. Ecology and DOH routinely follow the published literature and receive information from other agencies and organizations on this topic. If a promising alternative is identified or if new information shows that Deca-BDE use is changing or increasing, the agencies will consider whether a formal evaluation and report to the legislature is appropriate.

In addition to the requirements already described, RCW 70.76 includes notification and recall provisions applicable to manufacturers, requires Ecology to assist manufacturers and retailers to the extent practical, allows retailers to exhaust existing stock after a prohibition becomes effective and provides for civil penalties for manufacturers who do not comply.

III. Background: Deca–BDE

Deca-BDE is one of a large class of chemical compounds that act as flame retardants when added to consumer products. Flame retardants like Deca-BDE either prevent products from catching on fire or allow products to burn more slowly if exposed to flame or high heat.

Beginning in the early 1970s, three different mixtures of flame retardants called polybrominated diphenyl ethers or PBDEs were commercially manufactured. Deca-BDE is the only remaining mixture still in use. Production of two others PBDE mixtures, Penta-BDE and Octa-BDE, was voluntarily stopped in the U.S. by their manufacturers in 2004. Products containing Penta-BDE and Octa-BDE were subsequently banned in several states, including Washington, due to environmental and human health concerns.

Use in Electronics Enclosures and Flammability Standards

Deca-BDE can be used in many different plastics. The largest application of Deca-BDE is in high impact polystyrene (HIPS) plastic used in television and computer enclosures. Television enclosures are reported to account for approximately 45 – 80 percent of the Deca-BDE use in the U.S.[2,3]

The use of Deca-BDE in electrical and electronic products was banned in the European Union (EU) beginning July 1, 2008 under the European Restriction of Hazardous Substances (RoHS) directive. Therefore, Deca-BDE is no longer used in electronics sold in the EU. Deca-BDE was also banned in the State of Maine and similar restrictions are being considered in several other states.

Deca-BDE is added to HIPS at 10-15 percent by weight to meet fire safety standards.[4] Plastics used in electronic products are rated for their flame retardation capability using a voluntary standard identified by the National Fire Protection Association (NFPA)[5] in conjunction with the Underwriters Laboratory Inc. (UL) that defines the specific method. Although the NFPA standards are voluntary, they are often cited by Federal and State regulations as a definitive source for fire and combustion related technical information. In addition, products are typically manufactured to meet NFPA standards to minimize product liability concerns. Electronics enclosures using Deca-BDE meet the UL94 V-0 flammability rating; therefore the agencies looked for alternatives that could also achieve at least this level of fire safety.

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[2] The Lowell Center for Sustainable Production, Decabromodiphenylether: An Investigation of Non-Halogen Substitutes in Electronic Enclosure and Textile Applications, University of Massachusetts Lowell, 2005.
[3] Business Communications Company, Inc. (BCC), 2003. Flame Retardant Chemicals, C-004A. ISBN 1-56965-772-6. Marcanne Greene, author.
[4] Agency for Toxic Substances and Disease Registry (ASTDR), (2004) Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (PBBs and PBDEs), p. 373.
[5] Information on the NFPA is available at:
http://www.nfpa.org/categoryList.asp?categoryID=143&URL=About%20Us
Accessed 11/05/2008

UL Method 94, '*Test for Flammability of Plastic Materials for Parts in Devices and Appliances*,'[6] contains several tests that quantify the ability of plastics to withstand combustion. The V-0 rating is found in the 20 mm Vertical Burning Test section of UL94. In this test, 5 pieces of plastic are twice subjected to an open flame and discrete information is collected on how long the plastic continues to burn and smolder after the flame is removed. In addition, the combustion of the plastic is observed and it is noted if the plastic burns down to the clamp and if cotton placed beneath the plastic catches fire due to dripping, burning plastic. These criteria are subsequently compared to the various rankings (V-0, V-1, and V-2) with the V-0 being the most resistant to combustion. Therefore any alternative to Deca-BDE must meet this V-0 standard in order to maintain fire safety.

Use in Residential Upholstered Furniture and Flammability Standards

A contact at the federal Consumer Product Safety Commission (CPSC) states that research by that agency revealed that Deca-BDE is not currently used in the manufacture of residential upholstered furniture in the U.S. though it can be used in the vinyl back-coating of fabric cover materials to provide fire safety. Deca-BDE is currently used in this way to comply with fire safety requirements of the U.K. but U.S standards currently do not include a similar requirement.

California is currently the only state that has flammability performance requirements for residential upholstered furniture. These standards have been in effect since 1975. Flammability tests for residential upholstered furniture sold in California are described in California Technical Bulletins 116 (1980) and 117 (2000, most recent revision). In these standards, full scale pieces of furniture must comply with cigarette smoldering tests (TB 116) and upholstery filling materials. Other non-frame components must comply with small open-flame and cigarette smoldering tests (TB 117).[7, 8, 9] TB 117 is a mandatory standard and TB 116 is a voluntary standard that includes product labeling.

Furniture manufacturers primarily comply with the requirements of TB 117 by using flame retardant chemicals in polyurethane foam filling materials.[10] Penta-BDE had been used for this purpose prior to 2004, when its manufacturers halted production. Deca-BDE has never been used to provide fire safety for foam materials. Most cover fabrics can easily comply with the lenient open-flame test in TB 117 and do not require flame retardant back-coatings. Therefore, Deca-

[6] The UL method can be found at: http://ulstandardsinfonet.ul.com/scopes/0094.html, accessed 11/4/2008
[7] Polyurethane Foam Association (PFA), Joint Industry Foam Standards and Guidelines. Available at: http://209.85.173.104/search?q=cache:gcTamMwFnYkJ:www.pfa.org/jifsg/jifsgs14.html+Technical+Bulletin+117&hl=en&ct=clnk&cd=2&gl=us . Accessed Oct. 22, 2008.
[8] California Dept. of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, 2000. California Technical Bulletin 117. Requirements, Test Procedure and Apparatus for Testing Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture. March 2000. Available at: http://www.bhfti.ca.gov/industry/bulletin.shtml
[9] California Dept. of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, 1980. California Technical Bulletin 116. Requirements, Test Procedures and Apparatus for Testing the Flame Retardance of Upholstered Furniture. January 1980. Available at: http://www.bhfti.ca.gov/industry/bulletin.shtml
[10] Personal communication, Dale Ray, CPSC staff.

BDE has not been used to comply with TB 117 because it is not needed in fabric back-coatings and it is not used in polyurethane foam filling materials.

For commercial furniture used in public buildings, many states have adopted California's upholstered furniture flammability standard described in TB 133. Deca-BDE can be used in the back-coating of cover materials to comply with TB 133. It is unknown how much Deca-BDE is used to comply with commercial furniture flammability standards.

The CPSC recently published a proposed flammability standard for residential upholstered furniture that consists of a smoldering test for cover fabrics and a smoldering plus open-flame test for internal barrier materials. The proposed standard does not rely on the addition of chemical flame retardants, including Deca-BDE, for compliance.[11] Many existing cover fabrics can comply with the smoldering test without the use of flame retarded back-coatings. Deca-BDE can be used as a flame retardant in barrier materials to comply with the proposed open-flame test, but other options are available including the use of inherently flame retardant materials. If the proposed standard is finalized as currently written, furniture manufacturers will be able to meet fire safety requirements using design options such as fabric changes or the use of barrier materials, rather than with Deca-BDE or a chemical alternative.

Health and Environmental Impacts

Deca-BDE is a persistent, bioaccumulative toxic chemical (PBT) as defined by WAC 173-333 and has been banned in electronics in the EU and in several products sold in the State of Maine. Deca-BDE has been found to impact the developing nervous system. Recent studies have indicated neurodevelopmental and reproductive toxicity in animal studies with toxic effects as low as 6.7 mg/kg.[12] However, Deca-BDE is generally considered to be less toxic than other forms of PBDEs. Additional concern about Deca-BDE is driven by its potential to degrade in the environment; the breakdown products of Deca-BDE can be both more toxic and more bioaccumulative than Deca-BDE itself.

Many studies indicate that there is an increasing buildup of Deca-BDE in the environment, in the indoor environment, and in people.[13] The sources of exposure for this buildup are not well defined, although recent research indicates high levels of Deca-BDE in house dust and possible linkage between house dust, electronics and human exposure.[14]

[11] Consumer Product Safety Commission, 16 CFR Part 1634: Standard for the Flammability of Residential Upholstered Furniture Proposed Rule, Federal Register, March 14, 2008.
[12] EPA, 2008. IRIS file for bde-209.
[13] Lorber, 2007. Review: Exposure of Americans to polybrominated diphenyl ether. Journal of Exposure Science and Environmental Toxicology, (2007): 1-18.
[14] For example: Allen et al., *Linking PBDEs in House Dust to Consumer Products using X-ray Fluorescence*, Environ. Sci. Technol., **2008**, 42, 4222-4228.

The PBDE CAP reports on increasing detection of Deca-BDE in the environment and further work supports the conclusion that Deca-BDE levels are increasing in animals. For example, a 2008 study by Chen et al.[15] on Deca-BDE levels in Peregrine Falcon eggs stated:

> '*Temporal analyses indicated no significant changes in concentrations of total PBDEs, or most individual congeners during the study period. An exception was BDE-209* [deca-BDE]. *It exhibited a significant increase, with a doubling time of 5 years…. The high BDE-209 concentrations, short doubling time, and likely biodegradation observed in peregrine eggs from the northeastern U.S. may support the need for additional deca-BDE regulations.'*

Similar results were reported for Peregrine Falcons in China in 2007[16]. Numerous other examples exist of increasing detection of deca-BDE in animals around the world.

[15] Chen, et al., *'Polybrominated Diphenyl Ethers in Peregrine Falcon (Falco peregrines) Eggs from the Northeastern U.S.'*, Environ. Sci. Tech., 2008, 42 (20), pp 7594-7600

[16] Chen et al., '*Polybrominated Diphenyl Ethers in Birds of Prey from Northern China'*, Environ. Sci. Technol., 2007, 41 (6), 1828-1833.

IV. Alternatives to Deca-BDE in Television and Computer Electronics Enclosures

Identifying alternatives to Deca-BDE

In the 2006 PBDE Chemical Action Plan (CAP), Ecology and DOH identified two phosphate flame retardants, RDP and BAPP, as promising alternatives to Deca-BDE in electronic enclosures.[17] These two flame retardants were identified from a review of alternatives being marketed by flame retardant manufacturers at that time and were evaluated in several reports published in the U.S. and Europe.

These alternatives were identified as promising because they did not appear to have PBT characteristics; i.e. they were not likely to persistent in the environment or to bioaccumulate into organisms. Additionally, available toxicity data for RDP and BAPP indicated less of a concern for human health or aquatic organisms compared to Deca-BDE and its possible breakdown products. However, due to insufficient data at the time, the agencies decided that additional information was needed before these two alternatives could be recommended as safer alternatives to Deca-BDE.

Since the publication of the Chemical Action Plan, several new assessments of alternatives to Deca-BDE have become available. These new assessments include reports from:

- Maine DEP and Maine CDC, 2007
- Illinois EPA, 2007
- Danish EPA, 2007 & European Commission, 2007
- Clean Production Action, 2007

An overview of the methods and conclusions from each of these reports is provided in Appendix 1.

Based on the assessment of alternatives in the CAP and new information provided in the above mentioned reports, the agencies decided to focus on non-halogenated alternatives to replace Deca-BDE in electronic enclosures to address requirements in RCW 70.76. Halogen-containing flame retardants tend to be more persistent in the environment and to accumulate in organisms. At least one halogenated flame retardant that has been identified as an alternative to Deca-BDE in electronic enclosures, tetrabromobisphenol A, is classified as a PBT under Ecology's PBT Rule. Other brominated flame retardants reviewed in the Chemical Action Plan were found to be persistent or bioaccumulative. It should be noted that this review was not exhaustive, nor was it intended to be. The agencies focused on non-halogenated flame retardants because they appear to exhibit fewer undesirable characteristics than halogenated compounds. It is possible that there

[17] Ecology and DOH, 2006. Washington State Polybrominated Diphenyl Ether (PBDE) Chemical Action Plan: Final Plan. January 19, 2006.

are halogenated flame retardants that are safer than Deca-BDE and Ecology and DOH make no claims to the contrary.

The four reports above identify three possible non-halogenated alternatives to replace Deca-BDE in electronic enclosures: RDP, BDP (also referred to as BAPP), and triphenyl phosphate (TPP). Troitzsch[18] indicated that these three non-brominated flame retardants could be used to replace Deca-BDE and maintain a UL94 V-0 fire safety rating.

These three alternatives are currently marketed by flame retardant manufacturers for use in electronic enclosures. Information on all three is included in Table 1.

Table 1: Alternative Flame Retardants for Use in Electronic Enclosures

Flame Retardant	CAS Number	Manufacturer
RDP Resorcinol bis(diphenyl phosphate)	125997-21-9 57583-54-7[19]	Reofos® RDP by Chemtura Fyroflex RDP by Supresta[20]
TPP Triphenyl phosphate	115-86-6	Reofos TPP by Chemtura Phosflex TPP by Akzo Nobel
BAPP or BDP Bisphenol A bis(diphenyl phosphate)	181028-79-5	Reofos® BAPP by Chemtura[21] Fyrolflex® BDP by Supresta[22]

The European Union banned the use of Deca-BDE in electronics enclosures as of July 1, 2008, under the Restriction on Hazardous Substances (RoHS) Directive.[23] To produce televisions for the European market, electronics manufacturers must have identified alternatives that are technically feasible and allow their products to meet European fire safety standards. It is unknown whether the alternatives in use are safer or whether they would allow final products to meet U.S. fire safety standards. Reports published by the Karlsruhe Center and the European Commission in 2007 indicate that manufacturers in Europe were moving away from brominated flame retardants and that alternatives to Deca-BDE exist which maintain fire safety and meet the UL94 V-0 rating.[24,25]

The following graph shows the flame retardant market in the European Union for 2005. Based upon this information, brominated flame retardants such as Deca-BDE comprise only 11 percent

[18] J. Troitzsch, 2007. Commercially available halogen free alternatives to halogen-containing flame retardant systems in polymers.
[19] European Flame Retardants Association, "Flame Retardant Fact Sheet: Bisarylphosphates" http://www.flameretardants.eu/Objects/2/Files/BisarylphosphatesFactSheet.pdf, viewed 11 September 2008.
[20] Supresta Built In Defense, Safety Data Sheet, 29 November 2006, http://www.supresta.com/pdfs/FYROLFLEX%20RDP%20(English%20GB).pdf, viewed 11 September 2008.
[21] http://www.e1.greatlakes.com/fr/products/jsp/phosphorus_fr_prod.jsp?showAppMatrix=true#phosphorous_matrix, accessed 11/5/2008
[22] Karlsruhe Research Center, 2007
[23] http://www.endseuropedaily.com/articles/index.cfm?action=article&ref=25141 (April 2, 2008)
[24] European Commission report, 2007
[25] Karlsruhe Research Center, 2007

of the EU market while non-halogenated alternatives comprise 69 percent.[26] Phosphorous based flame retardants are only 8 percent of that market but, as manufacturers move away from halogenated alternatives, the percentage is expected to increase.

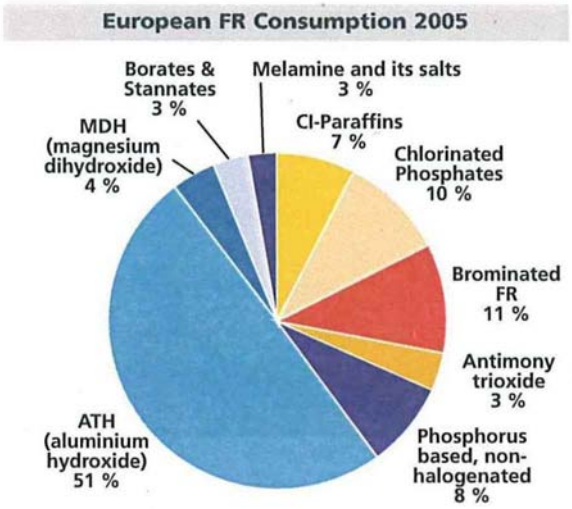

Figure 2: The current consumption of flame retardants in Europe, which amounts to a total of 463 800 metric tons (source: EFRA). Halogen-free FRs are shown in different shades of blue.

(From: Karlsruhe Research Center, 2007)

Many computer manufacturers have already moved away from the use of brominated flame retardants. Although details are scarce, television manufacturers for the U.S. market also appear to be transitioning toward phosphate and alternative flame retardants.[27] Great Lakes Chemicals, a major Deca-BDE manufacturer, indicates on its website that several, phosphorous-based alternatives to Deca-BDE (including RDP and TPP) can be used in 'TV Housings' and other electronic consumer products.[28] Sharp reportedly uses bisphenol A diphosphate as a flame retardant in their Aquos LCD TVs, and Philips was reported to be using 'phosphate esters' in their plasma TV housings.[29]

Exact information on the use of flame retardants is difficult to obtain. When working with suppliers, manufacturers typically define the characteristics of the product they want, for example, HIPS plastic that meets the UL94 V-0 flammability standard. Frequently, they do not require additional information, such as the type and amount of flame retardants used. As a result, the television manufacturers themselves often do not know what flame retardants have been used in the electronics enclosures of their products.

[26] Note: Although not a halogenated compound, Antimony trioxide is included in this group as it most often used in combination with a halogenated flame retardant
[27] Lowell Institute, 2005
[28] Great Lakes website at http://www.e1.greatlakes.com/fr/products/jsp/phosphorus_fr_prod.jsp?showAppMatrix=true#phosphorous_matrix, accessed 10/27/2008
[29] Lowell Institute, 2005

Use of Alternatives to Deca-BDE in TV Enclosures and Compliance with Flammability Standards

RDP

One of the manufacturers of RDP identifies it as a flame retardant that can be used in TV housings and consumer electronics[30] that can be used in HIPS/PPO and PC/ABS blends.[31]

RDP cannot be used in HIPS as a direct replacement for Deca-BDE. In order to use RDP, the manufacturer must use a different plastic to achieve the same fire safety rating.[32] Other plastic blends using RDP, such as HIPS/PPO or PC/ABS, have been identified as viable alternatives to Deca-BDE/HIPS in TV enclosures.

RDP is added to plastic at up to 20 percent by weight. For a given amount of plastic, more RDP must be added than Deca-BDE to maintain fire safety, that is, to achieve UL94 V-0 rating. Recent information however indicates that fire safety and the UL94 V-0 rating can be maintained with much lower levels of RDP. The Karlsruhe Research Center reported in 2007 results of their testing which indicated that the V-0 standard can be maintained in PC/ABS blends with as little as 9 percent RDP.[33]

RDP is being used in the EU. The Danish Report '*Deca-BDE and Alternatives in Electrical and Electronic Equipment*' states that RDP is "Used throughout Europe - roughly 20,000 metric tons in the EU TV enclosure market" although the report goes on to say that this value has not been corroborated and that it seems high. The report also identifies RDP as a viable alternative to Deca-BDE. The report states: "*Although the major producers have returned to V-1 or V-0 grade housings, they have not returned to Deca-BDE*."[34]

The same Danish report also addresses the use of flame retardants in LCD and other flat-panel TVs. The report states: "*The volume of flame retarded… plastic in enclosures of an average LCD panel TV-set, in which the back cover is typically flame retarded, is nearly the same as in an average CRT TV-set, because of the larger screen size of the LCD panel TV-sets. Therefore, the price estimate for FRs in CRT TV-sets may also be applied to the LCD panel TV-sets*."[35]

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[30] http://www.e1.greatlakes.com/fr/products/jsp/phosphorus_fr_prod.jsp?showAppMatrix=true#phosphorous_matrix, viewed, 11 September 2008.

[31] Great Lakes Flame Retardants, Reofos® RDP, http://www.e1.greatlakes.com/freb/products/content/static/reofos_rdp.html, viewed 11 September 2008.

[32] Troitzsch, 2007. Commercially available halogen free alternatives to halogen-containing flame retardant systems in polymers. Available at:

[34] Danish Ministry of the Environment, "Deca-BDE and Alternatives in Electrical and Electronic Equipment"

[34] Danish Ministry of the Environment, "Deca-BDE and Alternatives in Electrical and Electronic Equipment" 2006

[35] Danish Ministry of the Environment, 2006

A 2005 report from the Lowell Institute for Sustainable Production includes similar information: "*Roughly 61% of CRT monitors are made with PC/ABS resin systems using phosphate type flame retardants*."[36]

The Lowell Institute report also addresses the issue of the use of flame retardants in new flat-screen TVs. *"In 2003, the Sharp AQUOS held 50.9 percent of the world LCD market. The TV casing is made from PC/ABS resin using a phosphorus-based flame retardant. The cabinet meets the UL V-0 fire resistance standard. A 30 inch unit compared with a CRT TV of equivalent size (32-inch), consumes 38 percent less power, is one-sixth the depth, and weighs only one-third of the CRT TV."*[37]

TPP

Using TPP as a replacement for Deca-BDE would require manufacturers to switch from HIPS to HIPS/PPO plastic. TPP is added to HIPS/PPO at about 30 percent weight.[38] According to the Danish EPA, TPP is used in the EU as a substitute for Deca-BDE in electronics.[39]

Degradation of TPP, however, is a concern, especially for environmental effects. The primary degradation products from TPP are diphenyl phosphate and phenol. Ecology evaluated the acute and chronic aquatic toxicity for TPP and its degradation products and found that risks posed to the environment from TPP are more significant than for RDP (See Appendix 2).

BAPP (BDP)

Along with RDP, bisphenol A diphosphate (BAPP) is one of the most widely used non-halogenated flame retardants in electronic enclosures[40]. BAPP is a mixture of three components, two components with bisphenol A as a major constituent (>97 percent) and TPP (3 percent). Recent concern about the risks posed by bisphenol A suggests that more information is needed before this flame retardant can be considered as a safer alternative to Deca-BDE.

Health and Environmental Impacts

RDP

Ecology and DOH reviewed four new alternative assessments for Deca-BDE (Appendix 1). These assessments used different approaches for evaluating alternatives to Deca-BDE in

[36] Lowell Institute for Sustainable Production, "Decabromodiphenylether: An Investigation of Non-Halogen Substitutes in Electronic Enclosure and Textile Applications" 2005
[37] Lowell, 2005, page ??
[38] Karlsruhe Research Centre, 2007
[39] Danish EPA, 2007
[40] Green Screen, 2007, page 29

electronic enclosures and other products. Three of these assessments, from Maine, Illinois and Clean Production Action, specifically evaluated RDP as an alternative to Deca-BDE in electronic enclosures. All three reports recommended RDP as a safer alternative to Deca-BDE in electronic enclosures.

Information summarized in these reports and from other sources indicates RDP is not likely to be persistent in the environment and is estimated to have moderate potential to bioaccumulate in organisms. Estimated half-life of RDP is 40 days in fresh water and 17 days in water at 20º C and pH 7 and its partitioning coefficient (log Kow) is estimated to be 4.93.[41] Based on criteria in Ecology PBT Rule, neither RDP nor its main breakdown products would qualify as a PBT in Washington.[42] Currently, Deca-BDE and at least two of its breakdown products are on Ecology's PBT list.

One issue worth noting is that commercial RDP contains up to 5 percent of TPP (see below). Therefore, although it is difficult to completely separate the two chemicals, it is important to look at the toxicity of the major component as this will have the greatest impact on human health and the environment. Therefore because TPP is present at low levels in RDP, its impact is expected to be low because it is a minor component.

RDP itself can degrade to a number of constituents including its base components (resorcinol and diphenyl phosphate) and numerous methoxylates and hydroxylates. Upon further degradation, compounds with higher toxicity such as phenol are also possible. More study is needed to evaluate all possible degradation pathways and products. Based upon degradation studies of other flame retardants, as much as 50 percent or more of the original compound cannot be identified indicating multiple and intricate degradation pathways.

Studies in Europe indicate that, for some phosphate based flame retardants (typically TPP). 40-70 percent of the flame retardant is degraded during the waste water treatment process. Similar results are expected for RDP. Unlike Deca-BDE and its degradation products, all of these compounds are readily degraded in the environment. Given the complexity of the processes involved and the likelihood that toxic compounds like phenol would contribute only a very small amount to the degradation process, Ecology and DOH decided to concentrate on the primary degradation products until additional information is available.

Existing data summarized in recent assessments and from other sources indicate that RDP has lower toxicity than Deca-BDE. RDP and its major constituents are less toxic to aquatic organisms than Deca-BDE (Appendix 2). RDP has not been shown to cause the types of human health-related toxic effects observed for Deca-BDE including developmental and reproductive toxicity and neurotoxicity. A direct comparison of toxic effects levels across different types of animal studies shows that Deca-BDE produces toxicity at lower levels than RDP (Appendix 2). Unfortunately, there are only a limited number of animal toxicity studies for RDP with which to evaluate its toxicity. A recent assessment predicted RDP's toxicity based on its chemical

[41] Supresta, 2007. Environmental summary – bioaccumulation of Fyroflex RDP.
[42] Chapter 173-333 WAC (PBT Rule) criteria for persistence is half-life in water, soil, or sediments ≥ 60days, and for bioaccumulation is log Kow > 5 or BCF or BAF > 1,000.

structure. These predictions indicate a low concern for most toxic effects.[43] While modeling data such as this is useful, it does not provide as much information as experimental data. The agencies have demonstrated that ongoing use of Deca-BDE leads to build up of Deca-BDE in the environment and in people and that the breakdown of Deca-BDE provides an ongoing threat of exposure to the more toxic Penta and Octa-BDE[44]. Nevertheless, based on existing information, RDP is safer than Deca-BDE in that it is significantly less persistent and less toxic, especially when the breakdown products are considered.

TPP

The Danish EPA identified TPP as a less hazardous alternative.[45] The assessment by the Illinois EPA found TPP to be potentially problematic mainly due to its aquatic toxicity. TPP was included as part of the evaluation in Clean Production Action's Green Screen analysis of RDP and BAPP because it is a constituent in commercial RDP and BAPP products. Based on the Green Screen methodology, TPP was identified as a safer alternative (qualifies as Benchmark 2 in the Green Screen – see Appendix 1). While TPP was shown to have a favorable human health profile in the Green Screen methodology, this methodology gives aquatic toxicity a lower priority than human health-related effects.

Information reviewed for this report indicates TPP is not likely to be persistent in the environment and is estimated to have low potential to bioaccumulation in organisms.[46] Based on criteria in Ecology PBT Rule, TPP would not qualify as a PBT in Washington.

Unlike RDP, there are several toxicity studies available for TPP with which to evaluate toxicity related to human health and environmental organisms.[47] These studies indicate a mostly low potential for human health toxicity, but a high toxicity for aquatic organisms. Based on an indication of high aquatic toxicity in the reports from Illinois and Clean Production Action, Ecology conducted a more comprehensive review of aquatic toxicity data for TPP (Appendix 2) and concluded that TPP's aquatic toxicity precludes it from being cited as a safer alternative to Deca-BDE.

BAPP (BDP)

BAPP was evaluated as an alternative to Deca-BDE in electronic enclosures in the Maine, Illinois and Clean Production Action reports. The Maine assessment concluded that BAPP was not a suitable alternative to Deca-BDE because of its persistence and degradation to bisphenol A.

[43] Syracuse Research Corp., 2006. Flame Retardant Alternatives: an assessment of potential health and environmental impacts of RDP and BAPP, two phosphate-based alternatives to Deca-BDE for use in electronics.
[44] Washington State Polybrominated Dipheny Ether (PBDE) Chemical Action Final Plan, January 19, 2006. Department of Ecology publication no. 05-07-048.
[45] Danish EPA, 2007. Health report on alternatives…
[46] Syracuse Research Corp., 2006. Flame Retardant Alternatives: an assessment of potential health and environmental impacts of RDP and BAPP, two phosphate-based alternatives to Deca-BDE for use in electronics.
[47] Syracuse Research Corp., 2006. Flame Retardant Alternatives: an assessment of potential health and environmental impacts of RDP and BAPP, two phosphate-based alternatives to Deca-BDE for use in electronics.

Bisphenol A has been identified as an endocrine disruptor in recent animal toxicity studies. The Illinois assessment did not address the toxicity of one of BAPP's breakdown products. Clean Production's Green Screen analysis of BAPP concluded it was a chemical of high concern due the high toxicity concern associated with bisphenol A.

Due to concern about the endocrine disrupting effects of bisphenol A as a breakdown product of BAPP, Ecology and DOH dropped it from consideration as a safer alternative to Deca-BDE.

Fire Safety

The Fire Safety Committee was convened on November 7, 2009 to consider whether RDP meets applicable fire safety standards for electronic enclosures in TVs and computers. Ecology presented the following information to the committee:

- A description of the alternatives considered
- A detailed description of the UL Method 94 testing protocol
- A comparison of Deca-BDE and RDP
- Documentation of the performance of both flame retardants

Four out of five committee members were present as was the Washington State Fire Marshal and one representative of the public. After discussion, a motion was made in which the Fire Safety Committee found that RDP meets applicable fire safety standards. All four members present agreed. The absent member received all the presentation materials and agreed with his colleagues and voted with the majority. Subsequently, the Washington State Fire Marshal reviewed these findings and determined that RDP meets applicable fire safety standards (See Appendix 5).

Conclusions

RDP (resorcinol bis (diphenyl phosphate)) is a safer and technically feasible alternative to Deca-BDE. RDP's low environmental persistence, moderate bioaccumulation potential and moderate toxicity make it a safer alternative than Deca-BDE for use in electronic enclosures.

RDP provides comparable fire safety (UL94 V-0) to Deca-BDE for plastics used in electronic enclosures. The use of RDP in electronic enclosures requires the use of a different plastic than what is typically used with Deca-BDE. However, this switch in plastic is anticipated to be feasible and cost effective.[48]

The Fire Safety Committee and the State Fire Marshal found that RDP will meet applicable fire safety standards for televisions and computers.

Two other phosphate flame retardants were considered by Ecology and DOH as potential safer alternatives to Deca-BDE. These alternatives are BAPP and TPP. BAPP was identified initially as a feasible alternative to Deca-BDE; however one of its breakdown products, bisphenol A, has been identified as an endocrine disruptor in animal studies. Therefore the agencies determined that BAPP may not be a safer alternative to Deca-BDE.. TPP was identified is a feasible alternative; however concerns about its aquatic toxicity preclude it from being considered as a safer alternative at this time.

[48] Illinois report, 2007.

V. Alternatives to Deca-BDE in Residential Upholstered Furniture

Background on CPSC proposed flammability standard for residential upholstered furniture

Upholstered furniture design is complicated and involves many different materials. Currently, there are no federal flammability performance requirements for residential upholstered furniture, though state standards exist for upholstered furniture in commercial and institutional settings.

In March, 2008, the U.S. Consumer Product Safety Commission (CPSC) proposed a standard for flammability performance requirements of residential upholstered furniture. The proposed standard is a performance-based standard which allows manufacturers to meet the standard using one of two approaches. One option is to use cover materials that are sufficiently smolder-resistant to meet a cigarette ignition performance test. A second option is to place fire barriers that meet smoldering and open flame resistance tests between the cover fabric and interior filling materials.[49] Chemical flame retardants would not be required to meet the standard as proposed, though they could be used in certain cover fabrics. The CPSC indicates that furniture manufacturers have expressed interest in staying away from the use of flame retardants due to consumer concerns.

The CPSC accepted public comment on the proposed standard through May 2008. Comments submitted to the CPSC on the proposed standard included concerns about the lack of an open-flame test for cover fabrics, concerns about the lack of a standard for foam materials (similar to the California standard, see below), support for the standard because it doesn't require chemical flame retardants, concerns that the standard needs to reflect known and expected causes of household fires, concerns about the burdensome testing and reporting requirements, and comments about consistency with existing standards and testing procedures.[50]

One of the comments that the CPSC is considering for their final rule is related to comments submitted by the National Association of State Fire Marshals about concerns that the proposed standard is not protective enough because it doesn't account for ignition of foam materials. An open-flame test for foam materials was included in a previous CPSC staff draft standard in 2005. Comments submitted on the 2008 proposed standard asked that this requirement be added back into the standard to be consistent with California's standard and to address foam as cause of home fires.

In light of these public comments, CPSC may choose to modify the performance requirements to include an open flame standard for foam materials. However, Deca-BDE is not used in foam materials and could not be used or required to achieve compliance with an open flame standard

[49] Consumer Product Safety Commission, 73 Fed. Reg., 11,702 (proposed 4 March 2008)
[50] CPSC, public comment rulemaking, standard for the flammability of residential upholstered furniture. Available at: http://www.cpsc.gov/library/foia/foia08/pubcom/pubcom.html

for foam materials. Therefore, this report does not consider alternatives to Deca-BDE for this use. Upholstered furniture manufacturers would still have the option to meet the overall flammability standard without chemical flame retardants by choosing to use compliant fire barriers between the cover fabric and interior filling materials.

The CPSC is currently conducting additional analysis on the proposed standard and it is unknown when it will be made final or what specific testing requirements will be included in the standard.

On March 28, 2008, Gov. Gregoire signed Senate Bill 5642, which requires that only self-extinguishing cigarettes be sold in Washington.[51] This may reduce the number of fires caused by cigarettes.

Cover fabrics

Use in Residential Upholstered Furniture and Flammability Standards

The proposed CPSC flammability standard for residential upholstered furniture allows the use of cover materials that resist smoldering in a test meant to mimic fires caused by cigarettes, to comply with standard. The CPSC estimates that 90% of deaths and 75% of property damage from residential fires result from fires started by cigarettes.

Health and Environmental Impacts

Chemical flame retardants are not required to be used in cover materials to meet the proposed residential upholstered furniture flammability standard. The CPSC predicts that 14 percent of existing fabrics would fail. Furniture manufacturers whose existing fabrics fail could comply with the proposed standard without using chemical flame retardants by modifying fabrics or adding fire-resistant interior barriers (see below). The CPSC predicts the use of chemical flame retardants is possible to make complying cover fabrics, but is unlikely.[52]

Conclusions

The draft flammability standard for cover materials can be met without the use of chemical flame retardants. Therefore, there are safer and feasible alternatives to the use of Deca-BDE as a back coating in cover materials because no chemical flame retardants would be required to meet the CPSC proposed flammability standards.

[51] Washington State Legislature, SB 5642 2007 – 2008, http://apps.leg.wa.gov/billinfo/summary.aspx?bill=5642&year=2008, viewed 16 September 2008.
[52] Personal communication with Dale Ray, CPSC, Sept. 4, 2008.

Barriers

Use in Residential Upholstered Furniture and Flammability Standards

The proposed CPSC flammability standard for residential upholstered furniture allows the use of interior barriers that resist open flame and smoldering tests to comply with standard.

Health and Environmental Impacts

CPSC finalized a new mattress flammability standard in 2006.[53] Some of the barrier technologies used to meet the mattress standard could also be used to comply with the proposed flammability standards for residential upholstered furniture. Six flame retardants were identified by the CPSC for use in barriers in mattresses:

1. Ammonium polyphosphate
2. Antimony trioxide
3. Boric acid/Zinc borate
4. Deca-BDE
5. Melamine
6. Vinylidene chloride

The CPSC quantitatively estimated exposures and resulting health effects from the use of these flame retardants in mattress barrier materials.[54] The CPSC evaluation concluded that use of these six flame retardants presented no appreciable risk of health effects to consumers. Their conclusions for antimony trioxide, boric acid, and Deca-BDE were based on estimates of exposure that were much lower than toxic effect levels. Their conclusion for vinylidene chloride was based on the CPSC finding of no measurable migration of this flame retardant from mattresses indicating no potential for exposure. The CPSC determined that ammonium polyphosphate and melamine did not meet the definition of "toxic" under the Federal Hazardous Substances Act (FHSA) and exposures to these two flame retardants were not evaluated further.

Since CPSC's risk assessment, EPA has set a new lower toxicity value for Deca-BDE. The CPSC assessment focused only on exposures from mattresses and did not account for other exposures in the home or the potential breakdown of Deca-BDE to other more toxic PBDE congeners. Deca-BDE in the home, especially from house dust, has been identified as a main route of exposure to residents.

It is possible to avoid the use of these flame retardants altogether by relying on complying cover fabrics or inherently flame retardant barriers that require no added chemical flame retardants.

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[53] Consumer Product Safety Commission, 2006. Standard for the flammability (open flame) of mattress sets; final rule. March 15, 2006. 16 CFR 1633. Available at: http://frwebgate5.access.gpo.gov/cgi-bin/PDFgate.cgi?WAISdocID=786714252713+0+2+0&WAISaction=retrieve

[54] CPSC, 2006. Quantitative assessment of potential health effects from the use of fire retardant (FR) chemicals in mattresses. Available at: http://www.cpsc.gov/library/foia/foia06/brief/briefing.html (Tab D).

Fire Safety

The Fire Safety Committee was convened on November 7, 2009 to consider whether non-chemical alternatives to Deca-BDE in residential upholstered furniture meet applicable fire safety standards. DOH presented the following information to the committee:

- A description of the types of alternatives considered
- A detailed description of the CPSC mattress standard
- A detailed description of the proposed CPSC rule for upholstered furniture
- A description of the California furniture rule

Four out of five committee members were present as was the Washington State Fire Marshal and one representative of the public. After discussion, a motion was made in which the Fire Safety Committee found that non-chemical alternatives to Deca-BDE meet applicable fire safety standards. All four members present agreed. The absent member received all the presentation materials and subsequently agreed with his colleagues and voted with the majority. Subsequently, the Washington State Fire Marshal reviewed these findings and determined that non-chemical alternatives to Deca-BDE for residential upholstered furniture meet applicable fire safety standards (See Appendix 5).

Conclusions

The use of internal barrier materials may require the use of chemical flame retardants. The CPSC staff estimates that barriers would be used in only about 5 percent of upholstered furniture to meet the standard. Internal barriers are not required if compliant cover fabrics are used. Flame retardants could be used on cover fabrics, but the CPSC staff has indicated that fabric suppliers are unlikely to use flame retardants.

Overall Conclusions

For assessing available alternatives to Deca-BDE in residential upholstered furniture, Ecology and DOH identified uses of Deca-BDE in furniture as well as the availability of design options for those uses that could comply with fire safety standards. Ecology and DOH staff contacted CPSC staff regarding current use of Deca-BDE in furniture and expected use of Deca-BDE to comply with their proposed flammability standard. CPSC staff indicates that Deca-BDE is currently not being used by manufacturers to comply with California's residential furniture flammability standard (TB 117). Deca-BDE will not be required to comply with the CPSC proposed flammability standard for residential furniture. CPSC staff indicates that there are existing design options that can be used to meet the proposed standard that do not require the addition of any flame retardants, including Deca-BDE. For example, many existing synthetic cover fabrics could currently meet the CPSC's proposed standard. Additionally, there are inherently flame retardant barriers that could be used to comply with the proposed standard. Although the CPSC flammability standards have not been finalized, it is expected that design

options other than the use of Deca-BDE will be available to meet any additional requirements in a final standard.

The Fire Safety Committee and the State Fire Marshal found that non-chemical design changes meet applicable fire safety standards for residential upholstered furniture.

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Appendix 1: Recent Deca-BDE Alternatives Assessment Reports

Alternatives to Deca-BDE for use in electronic enclosures have been evaluated by other governmental and non-governmental organizations since the PBDE Chemical Action Plan was published in January 2006. These evaluations provided useful methods and other information for identifying safer alternatives. Four reports that evaluated the availability and safety of alternatives to Deca-BDE were identified and reviewed:

1. Maine DEP and CDC, 2007. Brominated Flame Retardants, 3rd Annual Report to the Maine Legislature.
2. Illinois EPA, 2007. Report on Alternatives to the Flame Retardant DecaBDE: Evaluation of Toxicity, Availability, Affordability, and Fire Safety Issues.
3. Danish EPA, 2007. Health and Environmental Assessment of Alternatives to Deca-BEE in Electrical and Electronic Equipment.
4. Clean Production Action, 2007. The Green Screen for Safer Chemicals: Evaluating Flame Retardants for TV Enclosures.

The following section provides summaries of these recent reports and their main conclusions about alternatives.

1. Maine DEP and CDC, 2007. Brominated Flame Retardants, 3rd Annual Report to the Maine Legislature.

This report was required under Maine's PBDE law of 2004.[55] Maine's PBDE law contains the intention to institute measures to reduce the risk posed by Deca-BDE beginning in 2008 "if a safer, nationally available alternative is identified." Maine's report included a detailed summary of the toxicity and environmental characteristics of Deca-BDE from the published literature available at the time.

Maine's report evaluated alternatives to Deca-BDE for several different consumer products including uses in plastics in electronic enclosures of TVs and computers, plastics in other electronic parts, wire and cables, and textiles in mattresses and upholstered furniture. Maine's report included several assumptions and exclusions identified ahead of time that guided their evaluation. For example, they reviewed only alternatives that met fire safety standards, they assumed that redesign options not requiring added flame retardants were safer and they excluded PBTs from any consideration as possible safer alternatives. In addition, they avoided consideration of chemicals that were persistent and bioaccumulative, chemicals that might end up in the indoor environment, and chemicals that were carcinogenic, mutagenic or reproductive toxicants.

[55] An act to reduce the contamination of breast milk and the environment from the release of brominated chemicals in consumer product, PL 2003, c. 629, Sec. 1. 38 MRSA §1609, effective July 30, 2004.

Maine's process for evaluating alternatives relied on a review of available information on alternatives and a comparison of these alternatives relative to Deca-BDE. Their evaluation did not establish or use a numerical ranking or prioritization scheme.

For alternatives in textiles, the Maine report concluded that alternatives are available that do not require the use of chemical flame retardants and therefore this approach is inherently safer. For alternatives to Deca-BDE in HIPS plastic used for TV and computer enclosures, Maine identified two alternatives: bisphenol A diphosphate (BAPP or BPADP) and resorcinol bis (diphenylphosphate) (RDP). The Maine report concluded that BAPP was not a suitable alternative due to its environmental persistence characteristics and its ability to degrade to bisphenol A, which is associated with toxic effects. The Maine report identified RDP as presenting a lower human health and environmental risk than Deca-BDE for use in HIPS plastic. The Maine report also concluded that there was limited data available with which to evaluate alternatives to Deca-BDE for other uses besides plastics used in electronic enclosures.

2. Illinois EPA, 2007. Report on Alternatives to the Flame Retardant DecaBDE: Evaluation of Toxicity, Availability, Affordability, and Fire Safety Issues.

The Illinois EPA prepared a report on alternatives to Deca-BDE in 2007 at the request of their Governor as a follow-up to their 2006 report on the review of scientific research on Deca-BDE.[56] The purpose of the 2007 alternatives report was to answer critical questions remaining from their 2006 report and to determine whether safer and affordable alternatives to Deca-BDE were available that met fire protection standards.

The Illinois report evaluated alternatives to Deca-BDE for use in HIPS plastic used in electronic enclosures, wire and cable, and textiles. They limited their evaluation to non-halogenated alternative flame retardants already in use or expected to be in use in the future. Their report also included a detailed evaluation of the cost of switching to various alternatives.

Illinois EPA developed a ranking scheme for evaluating alternatives to Deca-BDE. Their scheme consisted of first collecting information on and evaluating several toxicity endpoints including cancer, reproductive effects, developmental effects, systemic toxicity, local effects (direct contact), toxicity to environmental organisms, and environmental persistence and bioaccumulation potential. The level of concern for each endpoint was ranked as high, moderate, low or no evidence meeting specific criteria. Based on the evaluation of individual toxicity and environmental endpoints, each alternative was placed into one of four categories to reflect their overall assessment: potentially unproblematic, potentially problematic, insufficient data, and not recommended.

The Illinois EPA evaluated several flame retardants that have been identified by the U.S. Consumer Product Safety Commission for use in flame retarding textiles. The Illinois EPA concluded two of these were potentially problematic (boron compounds and antimony trioxide), that there was insufficient data for two other flame retardants (melamine and ammonium

[56] Illinois EPA, 2006. DecaBDE Study: A Review of Available Scientific Research; A Report to the General Assembly and the Governor in Response to Public Act 94-100. http://www.epa.state.il.us/reports/decabde-study/index.html

polyphosphates), and that one was not recommended (zinc borate). However, in Illinois' 2006 Deca-BDE review report, they concluded that there are several ways to achieve flame retardancy in textiles that do not require chemical flame retardants and are therefore without toxicity concerns.

For use in HIPS plastic in electronic enclosures, Illinois EPA evaluated non-halogen flame retardants that could be used in other plastic resins to replace Deca-BDE in HIPS plastic. Phosphate flame retardants that were identified as feasible alternatives to Deca-BDE cannot be used in HIPS. Instead, manufacturers using phosphate flame retardants would have to switch to a HIPS blend (HIPS/PPO) or different plastic (PC/ABS). Illinois EPA identified three organic phosphorus compounds that could be used in PC/ABS and HIPS/PPO resins: triphenyl phosphate (TPP), resorcinol bis (diphenylphosphate) (RDP), and bisphenol A diphenyl phosphate (BDP). Illinois EPA concluded that two of these phosphate flame retardants (RDP and BDP) were potentially unproblematic and that the other flame retardant (TPP) was potentially problematic based on concerns about aquatic toxicity.

3. Danish EPA, 2007

The Danish EPA evaluated human health and environmental impacts of alternatives to Deca--BDE used in electrical and electronic equipment. They identified alternatives to be evaluated as those being used in the EU based on a market analysis. The market analysis was sponsored by the Danish EPA and identified eighteen possible halogenated and non-halogenated substitutes for Deca-BDE in various polymers.[57] From the eighteen alternatives identified in the market analysis, six were chosen for further evaluation of health and environmental impacts based on a screening of data availability and a preliminary evaluation of PBT and CMR (carcinogenic, mutagenic and reproductive toxic) properties. The six flame retardants that were evaluated in their environmental and health assessment were: ethylene bistetrabromophthalimide (EBTPI), tetrabromobisphenol A (TBBPA), tetrabromobisphenol A carbonate oligomer, triphenyl phosphate, red phosphorus, and diethylphosphinic acid, aluminum salt.

The Danish EPA evaluated the selected alternatives by conducting a survey of each chemical's physical-chemical characteristics, ecotoxicity and environmental fate information, and toxicological data. Each alternative was then qualitatively compared to Deca-BDE in terms of five toxicity endpoints (carcinogenicity, mutagenicity, reproductive toxicity, endocrine disrupting effects and sensitization) and environmental characteristics (persistence, bioaccumulation and aquatic toxicity). The report concludes that all six flame retardants evaluated do not appear to have more negative impacts on the environment, health or consumer safety than Deca-BDE. Triphenyl phosphate is the only non-halogenated alternative evaluated in the Danish report to replace Deca-BDE in HIPS used in electronic enclosures. Use of triphenyl phosphate requires a change in plastic to PC/ABS or HIS/PPO.

4. Clean Production Action, 2007

[57] Danish EPA, 2006. Deca-BDE and Alternatives in Electrical and Electronic Equipment. Carsten Lassen and Sven Havelund (COWI A/S, Denmark), Andre Leisewitz (Öko-Recherche GmbH, Germany) and Peter Maxson (Concorde East/West Sprl, Belgium)

Clean Product Action is a non-governmental organization that promotes the use of safer and cleaner consumer products. The group developed the Green Screen for Safer Chemicals methodology as a tool to help businesses, governments, and individuals make decisions about chemicals they use or promote. This methodology is similar to EPA's Design for the Environment (DfE) alternatives assessment tool.[58] The Green Screen takes EPA's DfE process one step further by placing the chemicals evaluated into one of four categories that describes their overall health and environmental safety: Benchmark 1 – Avoid, chemical of high concern; Benchmark 2 – Use but search for safer substitutes; Benchmark 3 – Use but still opportunity for improvement; and Benchmark 4 – Preferred safer chemical. The characteristics that are used to place a chemical in each Benchmark are listed in Table 2.

Table 2: Green Screen Benchmarks and Characteristics

Benchmark	Characteristics	Conclusion
4	1. Readily biodegrades (low P) and, 2. Low bioaccumulation and, 3. Low human toxicity and, 4. Low ecotoxicity	Preferred chemical
3	1. Moderate persistence and bioaccumulation 2. Moderate ecotoxicity 3. Moderate human toxicity 4. Moderate flammability or explosiveness	Use, but still opportunity for improvement
2	1. Moderate persistence, bioaccumulation and toxicity (human or ecotoxicity) 2. High persistence and bioaccumulation 3. High persistence or high bioaccumulation with moderate toxicity 4. High flammability or explosiveness	Use but search for safer substitutes
1	1. High persistence, bioaccumulation and toxicity 2. Very high persistence and bioaccumulation 3. Very high persistence or bioaccumulation with high toxicity 4. High human toxicity for any priority effect (carcinogenicity, mutagenicity, reproductive or developmental toxicity, endocrine disruption, or neurotoxicity)	Avoid – Chemical of High Concern

As a case study for their newly developed Green Screen methodology, Clean Product Action evaluated Deca-BDE and two phosphate flame retardants (RDP and BAPP). These two phosphate flame retardants were chosen for evaluation because they can be used to replace Deca-BDE in TVs, which is Deca-BDE's primary use, and because the market for flame retardants in electronics is moving towards the use of non-halogenated chemicals. The Green Screen also

[58] EPA Design for the Environment, 2005. Environmental Profiles of Chemical Flame-Retardant Alternatives for Low-Density Polyurethane Foam. EPA/742-R-05-002A and B. Available at: http://www.epa.gov/dfe/pubs/index.htm#ffr

included the evaluation of triphenyl phosphate (TPP), another identified alternative to Deca-BDE in electronic enclosures, as part of both RDP and BAPP commercial mixtures.

The Green Screen methodology consists of ranking the level of concern for a range of human health and environmental toxicity endpoints and environmental characteristics. The human health-related effects included in the ranking for each chemical are: carcinogenic, mutagenic, reproductive, developmental, endocrine disruption, neurological, acute toxicity, systemic/organ effects, sensitization, irritation, and immune system effects. Acute and chronic ecological toxicity effects are included in the ranking as well as persistence and bioaccumulation potential. Breakdown products are explicitly included in the ranking as metabolites and degradation products. Each endpoint or characteristic is ranked for its level of concern as Low, Moderate, or High or very High based on a comparison to defined criteria. As is done in the EPA DfE methodology, the Green Screen indicates whether the toxicity and environmental fate information used in the ranking is based on experimental data or is predicted from modeled or analogue data.

Table 3, below, from the Green Screen summarizes the hazard profiles for Deca-BDE, RDP and BAPP. Although not one of the products explicitly evaluated in the Green Screen, Table 3 includes information about TPP. Clean Production Action, in their Green Screen report, summarizes toxicity data for several different health impacts (cancer, developmental toxicity, etc.) for Deca-BDE, RDP, and TPP. Each health impact is ranked as low, moderate, or high concern based on criteria developed in the Green Screen methodology. In addition to the level of concern for each endpoint, Table 3 indicates whether information about a particular health effect is based on experimental or is predicted based on modeling, analogue data or professional judgment. Shading in Table 3 indicates that endpoint is evaluated based on modeled or otherwise predicted information.

Most human health-related effects for RDP, TPP and their breakdown products are ranked as low or moderate concern. The one exception to this is phenol, which is a minor breakdown product and is not expected to contribute greatly to the toxicity of RDP. Several of the different health effects for RDP listed in Table 3 were derived using models or because there are some data gaps in the toxicity testing of RDP. Additional toxicity testing of RDP to fill these data gaps is recommended.

The Green Screen assessment of Deca-BDE alternatives in electronics concludes that RDP and TPP meet the Benchmark 2 criteria: Use but search for safer alternatives. BAPP is categorized as Benchmark 1: Avoid due to it breakdown to bisphenol A which exhibits toxicity for a high priority endpoint (endocrine disruption). Deca-BDE is also categorized as Benchmark 1 – Avoid due to its breakdown to PBT compounds.

Conclusions

Three recent assessments identified RDP as a safer and feasible alternative to Deca-BDE for electronic uses. In Maine, the state legislature passed a law banning the use of Deca-BDE in electronics and furniture based on the evaluation of alternatives done by the Maine EPA and CDC. While the assessment by Maine, Illinois and Clean Production Action acknowledge

toxicity data deficiencies for RDP, they conclude that available data indicates RDP is not a PBT and that available information indicates that it has lower toxicity than Deca-BDE.

Table 3: Excerpted from Table 5 in The Green Screen, Evaluating Flame Retardants for TV Enclosures (Clean Production Action, 2007).

			Human health effects												
	% in formulation		**carcinogen**	**mutagen**	**reproductive toxicity**	**developmental toxicity**	**endocrine disruption**	**neurotoxicity**	acute toxicity	systemic toxicity	skin sensitivity	respiratory sensitivity	skin irritation	eye irritation	immune system
Chemical (Flame retardants)		CAS #													
RDP Mixture (mixture of following 3 components)		125997-21-9													
RDP (Resorcinol bis(diphenylphosphate))	65-80	57583-54-7	L	L	L	L	ND	L	L	M	L	ND	L	M	L
Phosphoric acid, bis [3-[(diphenoxyphos phinyl) oxy] phenyl] phenyl ester	15-30	98165-92-5	L	L	L	L	ND	L	L	M	L	ND	L	M	L
TPP (Triphenylphosphate)	<5	115-86-6	L	L	L	L	ND	L	L	M	L	ND	L	M	L
Breakdown products:															
Phenol		108-95-2	L	M	L	L	L	M	M	H	L	L	H	H	M
Resorcinol		108-46-3	L	L	L	L	M	M	M	ND	M	ND	M	M	ND
Diphenylphosphate (DPP)		838-85-7	Insufficient Data												
deca-BDE	97	1163-19-5	M	L	L	M	M	M	L	L	L	ND	L	L	ND
penta-BDE		32534-81-9	ND	L	M	M	H	M	L	H	L	L	M	M	ND
octa-BDE		32536-52-0	ND	L	M	H	M	M	L	H	L	ND	L	L	ND

ND = not data
Bold health effects indicates "priority effects" defined in the Green Screen.
Shaded (darker) cell colors for L, M or H indicates based on modeled or analogue data.

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UL standards: http://www.ul.com/plastics/flame.html

Appendix 2: Comparison of toxicity information for Deca-BDE, RDP and TPP

Human Health Toxicity Comparison of Deca-BDE, RDP and TPP

Table 4 summarizes the animal toxicity studies and toxic effect levels observed in these studies for Deca-BDE, RDP and TPP. This information includes the types of toxicity studies conducted for each chemical, the doses that were tested in these studies, and the doses that produced an observed toxic effect. This summary is meant to give a sense of the different types of toxicity tests conducted for Deca-BDE compared to those for RDP and TPP, and how the toxic effect levels differ between the three. The terms NOAEL and LOAEL are used in this table to indicate the highest dose in a study that did not produce an observed toxic effect (NOAEL) and the lowest dose for which a toxic effects was observed (LOAEL).

This information is mainly taken from a review of toxicity information for RDP and TPP compiled by Syracuse Research Corporation under contract for the Washington State Department of Ecology. Information about Deca-BDE toxicity studies is mainly derived from EPA's new IRIS file for Deca-BDE released in 2008.

Deca-BDE has been tested for developmental neurotoxicity, reproductive effects and immunotoxic effects in rodents. The effects levels observed in these animal studies range from between 6 mg/kg-day for developmental and immune system effects to 500 mg/kg-day for reproductive effects. These studies have been conducted in the last several years and are reviewed in the EPA IRIS file for Deca-BDE as support for their new toxicity assessment. Older studies of Deca-BDE include a 2 year chronic oral bioassay in rats, a subchronic bioassay in rats and a 2-year cancer study, which looked at different types of health effects that are not as sensitive as the developmental effects observed in the more recent studies.

Based on existing toxicity studies, Deca-BDE produces toxicity at much lower doses than RDP. None of the RDP animal toxicity studies have identified a toxicity effect level (LOAEL). The NOAELs found for RDP range from between 1000 mg/kg to 5000 mg/kg-day. The animal studies for TPP also indicate lower toxicity than Deca-BDE, with LOAEL ranging from 345 – 700 mg/kg-day.

It should be noted that the types of toxicity studies done for RDP and TPP are different than the studies done for Deca-BDE. For example, the types of developmental toxicity studies done with Deca-BDE have not been conducted with RDP and TPP. In addition, there are fewer toxicity studies available on RDP and TPP compared with Deca-BDE which makes the comparison between these chemicals challenging.

Table 4: Comparison of human health-related toxic effect levels for Deca-BDE, RDP and TPP:

Flame Retardant	Type of toxicity study/endpoint	NOAEL	LOAEL	Comments/reference
Deca-BDE	Developmental neurotoxicity (in rats) (Viberg et al., 2007)	Not determined	6.7 mg/kg (behavior changes)	One dose on postnatal day 3, unusual study design (EPA IRIS, 2008)
	Developmental neurotoxicity (in mice) (Viberg et al., 2003)	2.22 mg/kg [Basis for new RfD]	20.1 mg/kg (behavior changes)	One dose on postnatal day 3, 10 or 19, unusual study design (EPA IRIS, 2008)
	Developmental and immune system effects (male and female mice) (Rice et al., 2007)	Not determined	6 mg/kg-day (reduced thyroid hormone levels; abnormal behavior and activity)	Exposure post natal days 2-15; 99.5% purity BDE-209 (EPA IRIS, 2008)
	Reproductive effects (in mice) (Tseng, 2006)	100 mg/kg-day	500 mg/kg-day (reduced sperm activity)	(EPA IRIS, 2008)
	Thyroid effects; serum thyroid levels and hepatic enzymes (Zhou, 2001)	100 mg/kg-day	Not determined	Dose levels: 0, 0.3, 1, 3, 10, 30, 60, 100 mg/kg-dy (EPA IRIS, 2008)
	2 year chronic oral bioassay (in rats). Endpoints: blood work, food consumption, organ and body weight, and neoplastic lesions. (Kociba et al., 1975)	1.0 mg/kg-day [Basis for old RfD of 0.01 mg/kg-day	Not determined	Dose levels: 0, 0.01, 0.1, 1.0 mg/kg-day. Deca product contained ~77% deca-BDE; effects may be related to other congeners. (EPA IRIS, 1995)
	Subchronic (30 day) oral bioassay (in rats) (Norris et al., 1973, 1975)	8 mg/kg-day	80 mg/kg-day (liver enlargement)	Deca product contained ~77% deca-BDE. (EPA IRIS file, 1995)
	2-year cancer study (NTP, 1986). Studies conducted in rats and mice; both sexes.	Not determined	2500 – 5000 g/kg-day (neoplastic nodules; males only at 2500)	High doses: 2500 g/kg-day = 2,500,000 mg/kg-day (Birnbaum and Staskal, 2004)

Flame Retardant	Type of toxicity study/endpoint	NOAEL	LOAEL	Comments/reference
RDP	2 generation rodent study (31 weeks); developmental/ reproductive effects; reprod. performance & fertility, body + organ weights (Henrich et al., 2000)	>20,000 ppm (2%) (equivalent to 1203 mg/kg-day, males; 1305 mg/kg-day females)	Not determined	Technical products, Fyrolflex RDP, unreported % of RDP. Incomplete histopathology per guidelines. (Syracuse Research Corp., 2006)
	Subchronic (28 day) toxicity study (Arthur Little, 1989); male and female rats.	1000 mg/kg (liver weights)	Not determined	Unknown RDP content in test mixture. (Syracuse Research Corp., 2006)
	Prenatal developmental toxicity study in rabbits; exposure gestational days 6-28 (Ryan et al., 2000)	1000 mg/kg	Not determined	Unknown RDP content in product. (Syracuse Research Corp., 2006)
	Immunotoxicity. Battery of immune function tests, survival + bodyweight (in mice). Subchronic, 28 days (Sherwood et al., 2000)	5000 mg/kg-day	Not determined	Incomplete histopathology. (Syracuse Research Corp., 2006)
	Genotoxicity: Negative gene mutation in bacteria + chromosomal aberration, in vitro + in vivo	-	-	(Syracuse Research Corp., 2006)
TPP	Reproductive/ developmental. 91 days prior to mating, gestational day 20. Fertility + gross pathology. (Welsh et al., 1987)	Not determined	690 mg/kg-day (decreased body weight)	Lacks histopathology per current guidelines. (Syracuse Research Corp., 2006)
	Neurotoxicity; neurobehavioral effects. 4 month diet study in male rats. (Sobotka et al., 1986)	161 mg/kg-day	345 mg/kg-day (decreased body weight)	(Syracuse Research Corp., 2006)
	Immunotoxicity study. 4 month diet study in male and female rats. (Hinton, 1987)	517 mg/kg-day	700 mg/kg-day (decreased body weight)	(Syracuse Research Corp., 2006)

NOAEL = No observed adverse effect level,
LOAEL = Lowest observed adverse effect level

Aquatic Toxicity of Alternatives to Deca-BDE

An assessment of the aquatic toxicity impacts of RDP was included in several of the reports reviewed by Ecology and DOH for this update of the safer chemical alternatives assessment. However, the increased importance being placed on improving the health of the Puget Sound warranted a more detailed review. Ecology assessed aquatic toxicity of RDP using the Green Screen process identified in the report '*Evaluating FlameRetardants for TV Enclosures*' published by Clean Production Action.[59] Ecology used additional sources of information which were not included in the Green Screen, including EPA's Ecotoxicology database (ECOTOX), and NIH's Hazardous Substances Database (HSDB).

Acute and chronic aquatic toxicity was assessedfor RDP, another phosphate flame retardant (triphenyl phosphate or TPP), their degradation products, and Deca-, Octa- and Penta-BDE. The specific chemicals subjected to this evaluation are the following:

- RDP (resorcinol bis(diphenyl phosphate))
- TPP (triphenyl phosphate)
- Degradation products:
  - Phenol
  - Resourcinol
  - Diphenyl phosphate
  - Sodium triphosphate
  - Sodium phosphate
- Deca-BDE (deca brominated diphenyl ether)
- Octa-BDE (octabrominated diphenyl ether mixture)
- Penta-BDE (pentabrominated diphenyl ether mixture)

Sodium triphosphate and sodium phosphate were included in the evaluation due to concerns about increased deposition of phosphate from flame retardants into aquatic bodies. This concern is particularly important given current efforts to limit phosphates in laundry detergents and other consumer products because of the adverse impact phosphates have upon the health of aquatic bodies. This issue is addressed more in Appendix 3.

Seventeen sources were used for this evaluation including many of the reports already cited in this report, risk assessments conducted by the European Union, toxicity databases maintained by EPA, etc.

Aquatic Toxicity Comparison

[59] Rossi and Heine, '*The Green Screen for Safer Chemicals: Evaluating Flame Retardants for TV Enclosures*', Clean Production Action, March 2007, found at: http://cleanproduction.org/library/Green%20Screen%20Report.pdf

Based upon the information obtained on aquatic toxicity, Ecology compared each of the individual compounds and degradation products. Each of the toxicity criteria were assigned a 'low', 'medium' or 'high' value depending upon the numerical values obtained.

Acute and chronic aquatic toxicity values were ranked for all chemicals included in this evaluation. The result of this ranking is found below.

Table 5: Summary of Aquatic Toxicity

Chemical	CAS	%	Acute Toxicity	Chronic Toxicity
Flame retardants				
RDP Mixture (mixture of following 3 components)	125997-21-9	NA	**Medium**	**Medium**
- **RDP** (Resorcinol bis(diphenylphosphate))	57583-54-7	65-80	**Medium**	**Medium**
- Phosphoric acid, bis[3-[(diphenoxyphosphinyl) oxy]phenyl]phenyl ester	98165-92-5	15-30	**Low**	**Low**
- **TPP** (Triphenylphosphate)	115-86-6	<5	**High**	**High**
Breakdown products:				
- Phenol	108-95-2		**Medium**	**Medium**
- Resorcinol	108-46-3		**Med-Low**	**Med-Low**
- Diphenylphosphate (DPP)	838-85-7		**Insufficient**	**data**
- Sodium triphosphate	7758-29-4		**Low**	**Low**
- Sodium phosphate	7558-80-7		**Low**	**Low**
Deca-BDE	1163-19-5		**High**	**High**
Octa-BDE	32536-52-0		**High**	**High**
Penta-BDE	32534-81-9		**High**	**High**

Insufficient data was available to determine the impacts of diphenylphosphate as it appears few toxicity evaluations have been done on this chemical. Based upon this evaluation, concerns were identified with the PBDE species and TPP.

Ecology conducted a worst case analysis to assess the potential threat to surface waters from increased discharges of phosphates that might occur if all of the brominated flame retardants currently in use were replaced by phosphate containing alternatives. Ecology is concerned about the health of the water resources such as the Puget Sound and the Columbia River. Phosphates

in detergents and other consumer products have a long history of negatively impacting water quality.

Full details of this evaluation can be found in Appendix 3. For the purposes of this analysis, Ecology made the following, worst case assumptions:

1. All of the Deca-BDE currently used in electronic enclosures was replaced by TPP.[60] (the Deca-BDE alternative which has the highest phosphate loading).
2. The amount of TPP used would increase by 20 percent as more TPP is needed to maintain the same level of fire safety as does Deca-BDE.
3. All of the TPP used in electronic enclosures is released within one year (as opposed to the full lifetime of the consumer product.)
4. All of the TPP would be released only to the Puget Sound.

Even under these worst case assumptions, the amount of phosphate loading from phosphate flame retardants would be minor and would not pose any additional threat to the waters of the State.

Ecology also attempted to address concerns about the long-term impact phosphate flame retardants upon the environment. Little information is available specifically on RDP although considerable research had been done on TPP in Europe. In summary, phosphate flame retardants are being found in the environment. However, unlike PBDE, phosphate alternatives degrade readily while being processed at a waste water treatment plant (WWT). One Swedish study found that 56 percent of the incoming TPP was degraded during the treatment process.[61] A similar German study indicated at between 40 to 75 percent of the TPP coming into the WWTP was reduced before discharge.[62] In an early study by Monsanto in the U.S., phosphate esters like TPP were found to exhibit low aqueous solubility, moderate potential for bioconcentration and readily undergo primary and ultimate biodegradation.[63] Assuming that all phosphate based flame retardants exhibit characteristics similar to TPP, they have one major advantage over their PBDEs in that they do not persist to the same degree and are more readily removed from the environment.

Conclusions

The review of the aquatic toxicity information indicates that RDP poses less of a risk to aquatic species for both acute and chronic toxicity than does Deca-BDE. Similar conclusions are reached when all toxicity criteria are evaluated and the Green Screen process assigned RDP an overall

[60] TPP was used instead of other phosphate alternatives because, as phosphate comprises the highest percentage of it weight, TPP would provide the highest amount of phosphate when released into the environment. It is unlikely however the selection of another non-brominated phosphate flame retardant for this analysis would change the end result.

[61] Marklund, et al. '*Organophosphorus Flame Retardants and Plasticizers in Swedish Sewage Treatment Plants*', **Environ. Sci. Tech.**, 39, 2005.

[62] Meyer and Bester, '*Organophosphate flame retardants and plasticizers in wastewater treatment plants*', **J. Environ. Monit.**, 6, 2004.

[63] Saeger et al. '*Environmental Fate of Selected Phosphate Esters*', **Environ. Sci. Technol.**, 1979.

status of ‘Benchmark 2: Use but Search for Safer Substitutes.’ This assessment does not indicate that RDP is a preferred chemical, only that it poses less of an impact to human health and the environment than Deca-BDE. Ecology and DOH support continued work in the area of flame retardants and support work to identify flame retardants which could be classified as ‘Benchmark 4: Safer Chemical’ while maintaining fire safety.

RDP was reviewed by other states and found to be a viable alternative to Deca-BDE. It has been identified by Illinois and Maine as a safer alternative to Deca-BDE. Illinois identified RDP as “potentially unproblematic” and Maine identified RDP as a non-PBT and significantly lower threat.

TPP is not a PBT as it readily degrades in the environment. European studies show that TPP is degraded anywhere between 40 and 70 percent in a POTW while Deca-BDE has been shown to degrade only by about 2 percent. Therefore it does have the added benefit of degrading in the environment unlike deca-BDE and other halogenated flame retardants which persist for much longer periods of time.

As also identified earlier, TPP would have negligible impact on aquatic loading using very non-conservative assumptions. In addition, although RDP and TPP require use of PTFE during formulation as an anti-dripping agent, the amount of PTFE used in this process would have minimal impact on human health and the environment.

Based on the overall evaluation of human and aquatic toxicity, RDP is assigned to the Green Screen ‘Benchmark 2: Use but Search for Safer Substitutes.’ Because of its aquatic toxicity concerns and the emphasis Ecology and DOH are placing on protecting the waters of the State, Ecology and DOH cannot recommend TPP as a safer alternative to Deca-BDE.

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Appendix 3: Impact to Water Quality from Phosphate Alternatives

Summary

Based on a series of worst case assumptions, replacement of Deca-BDE with phosphate alternatives would increase the amount of phosphate loading to Puget Sound by slightly less than 2 percent. In actuality, the increase of phosphates to the Sound would be only a fraction of this amount and likely to be several orders of magnitude lower. Since the amount of phosphate from this source is so small given other sources and the conservative nature of the assumptions used, further research to quantify this source is not needed.

Amount of Phosphate Involved

In 2001, 24,500 metric tons of Deca-BDE was used in products sold in North America (WA PBDE Chemical Action Plan, Table 1, page 6). If one were to assume that all of these products were used only within the U.S. and that Washington State received a proportionate share based on its population, 490 metric tons of Deca-BDE was sold in products in Washington State. Four hundred ninety metric tons is equal to 490,000 kilograms of Deca-BDE.

Several reports have indicated that a higher concentration of phosphate flame retardants are needed compared with their brominated alternatives in order to maintain fire safety. If one assumes 20 percent more RDP is needed than Deca-BDE, this converts into 588,000 kilograms of RDP which would equal the Deca-BDE used in 2001. RDP is used instead of other phosphate flame retardants like TPP because the amount of phosphate in the RDP is higher percentage of the overall weight of the compound.

RDP has the structural formula of $C_{30}H_{24}O_8P_2$ and a molecular weight of 574.47. Phosphorus has a molecular weight of 30.1. Therefore the amount of total phosphorus in RDP is 10.97 percent of the total weight of RDP (2 x 20.1/574.47). Based on this ratio, the amount of total phosphorus in RDP sold in WA in 2001 is 63,460 kilograms (588,000 x 0.1097).

If one makes the following worst case assumptions:

- All of the phosphorus in RDP is released within 1 year.
- The release rate is constant over that period.
- All of the RDP is released only to the Puget Sound, i.e. no releases elsewhere within the state.

The amount of phosphorus loading from RDP to the Puget Sound would equal about 175 kg/d (63,460 kilograms/365 days).

Phosphate Loading to the Puget Sound

Information on phosphate loading to Puget Sound is incomplete. Ecology conducted one study which evaluated phosphate loading to the Puget Sound below Edmonds. This information can be found in the report *South Puget Sound Water Quality Study, Phase 2: Dissolved Oxygen-Interim Data Report, June 2008'*. Another study looked at toxic chemical loading to all of Puget Sound but did not include phosphate as one of its chemicals of concern. This information can be found in *'Control of Toxic Chemicals in Puget Sound Phase 1: Initial Estimate of Loadings'*. Data can be combined from the two reports to give an estimate of total phosphate loading to the Sound.

For this evaluation, only two sources of total phosphate, 1) discharge from Waste Water Treatment Plants (WWTPs) and 2) input from stream flows, were considered. Several other inputs to the Sound were not included in this evaluation such as:

- Industrial discharges.
- Combined sewer overflows.
- Storm water.
- Fertilizer run-off and run-off from exposed soil.
- Etc.

Many of these sources contribute considerable additional phosphate loading to the Sound. Therefore the estimate of total phosphorus loading to the Sound provided here is appreciably lower than the actual loading but it does allow the reader to evaluate the difference in scale between these inputs. It is important though to remember that the amount of phosphate from flame retardants is overestimated while phosphate loading to the Sound from other sources is underestimated.

<u>Loading from WWTPs:</u>

Page 95 of the South Puget Sound report identifies the **total phosphorus loading from WWTPs as 2,900 kg/day** (see info below).

Figure 62 presents phosphorus loads from wastewater treatment plants by region. South Puget Sound produces an average of 283 kg/d. Commencement Bay and South Sound produce an average of 493 kg/d, accounting for 17% of the total 2,900 kg/d of total phosphorus discharged from wastewater treatment plants south of Edmonds.

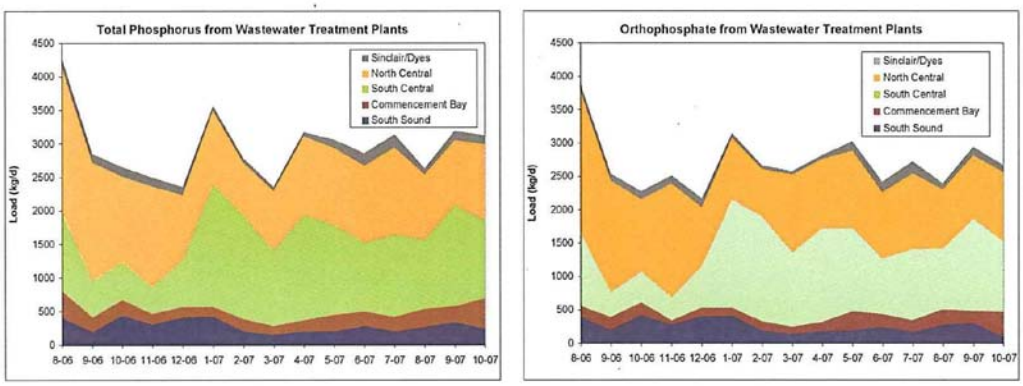

Figure 62. Phosphorus loads (kg/d) from wastewater treatment plants by region.

Loading from Stream Runoff:

This estimate requires the combination of information from the two reports. The Control of Toxic Chemicals in Puget Sound report includes an estimate of the amount of stream water reaching the Sound. The table below (Table 3 on page 59 of the Toxics Loading Report) indicates that the total stream runoff to the Puget Sound equal 1,717 m^3/sec. This translates into 148,348,800,000 liters per day.

Table 3 - Study Unit Runoff Rates

Study Unit	Mean Runoff Rate (cubic meters per second)					
	January	February	March	April	May	June
Main Basin	743	442	343	323	480	595
South Sound	458	327	292	226	204	197
Hood Canal	343	198	199	148	163	151
Whidbey Basin	836	625	599	598	691	733
Bellingham	198	170	148	150	181	192
Olympic Peninsula	202	171	136	123	166	190
TOTAL	**2,780**	**1,934**	**1,717**	**1,567**	**1,885**	**2,058**

Study Unit	Mean Runoff Rate (cubic meters per second)						
	July	August	September	October	November	December	Average Annual
Main Basin	368	128	119	195	571	550	**405**
South Sound	137	98	89	137	269	372	**234**
Hood Canal	91	51	43	119	251	306	**172**
Whidbey Basin	574	357	314	472	736	777	**609**
Bellingham	138	83	74	111	200	206	**154**
Olympic Peninsula	130	71	52	93	175	211	**143**
TOTAL	**1,437**	**789**	**690**	**1,128**	**2,202**	**2,423**	**1,717**

The South Puget Sound report estimates the concentration of total phosphorus for 30 streams within the boundaries of the study. Many of these are major inputs of runoff to the Puget Sound. Based on the information found in Figure 50 in the South Puget Sound Report (below), a value of 0.05 mg/L is selected for an average runoff total phosphorous concentration.

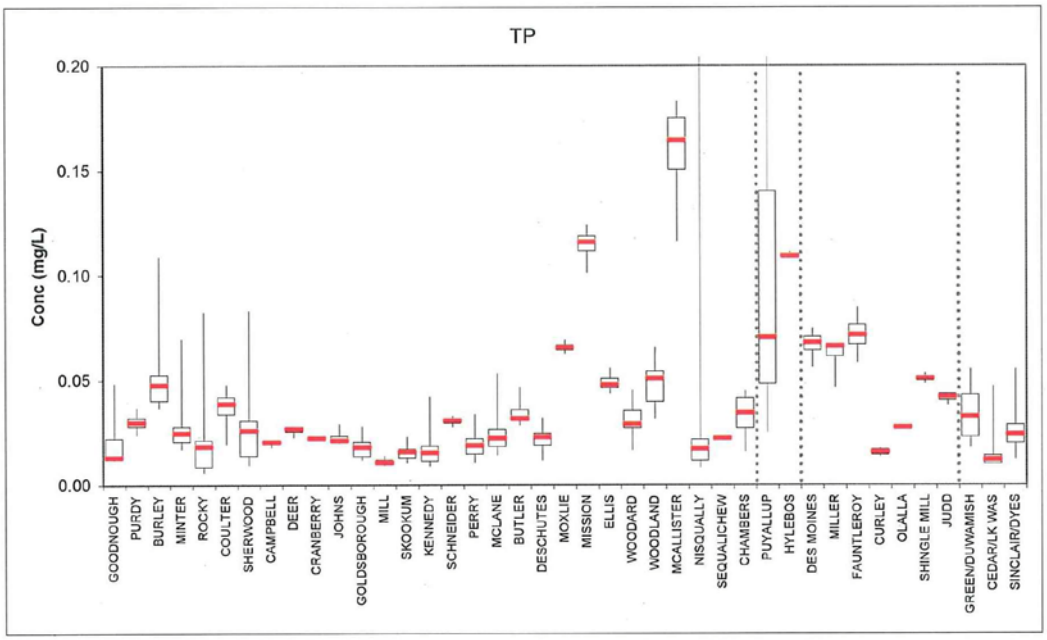

Figure 50. Total phosphorus concentrations in rivers and tributaries. Boxes represent the 25th and 75th percentile concentrations, thick red lines indicate the 50th percentile (median) concentrations, and lines extend to the minimum and maximum values.

Given an average concentration of 0.05 mg/L and an average runoff of 148,348,800,000 liters per day, the mass of total phosphorus can be calculated and determined to be 7,417 kg/d.[64]

Combining these two phosphorus sources, Ecology calculates that a worst case estimate of phosphorus loading to Puget Sound is 10,317 kg/d .

Comparison of existing sources with RDP

Based on the information above, the total phosphorus loading can be identified:

1. Loading from RDP = 173.86 kg/d
2. Loading from WWTP and stream runoff = 10,317 kg/d

Therefore as a worst-case evaluation, the potential loading from RDP would constitute an increase of 1.69 percent.

[64] Note: In order to compare the impact of selecting 0.05 mg/L as the stream loading, the calculation was also done using the lower value of 0.025 mg/L. The phosphorus loading decreased to 3,709 kg/d and the overall percentage increased to 2.63%. Therefore the final result does not alter appreciably if lower stream concentrations levels are used.

Appendix 4: Marketing Information from a Manufacturer of Flame Retardants

A major manufacturer of Deca-BDE also markets phosphate alternatives and provides information on the types of products in which these phosphate alternatives can be used. The following is a copy of the table from the manufacturer's website. It is meant to demonstrate the range of products for which phosphate flame retardants are feasible.

Phosphorous-Based Products by Application View phosphorous-based products by polymer

Great Lakes FLAME RETARDANTS

Phosphorous-Based	BUILDING & CONSTRUCTION	Adhesives & Coatings	Furniture	Insulation	Mattresses	Roofing	Textiles	Transportation	Wall/Floor Covering	ELECTRICAL COMPONENTS	Circuit Boards	Connectors, Relays & Switches	CONSUMER PRODUCTS	Appliance Housings	Battery Casings	Business Machines	Consumer Electronics	TV Housings	WIRE & CABLE	Conduit	Plenum Cable	Transport Cable	Power Cable	Building Cable	Appliance Cable
Reogard® 1000 new		III	III	III		III		III						III	III		III			III					
Reogard® 2000 new		III	III	III		III		III						III	III		III			III					
Reofos® 35		III		III		III	III		III		III														
Reofos® 50		III	III	III	III	III	III	III	III																
Reofos® 65		III	III	III	III	III	III	III	III													III	III	III	III
Reofos® 95		III	III	III	III	III	III	III														III	III	III	III
Kronitex® CDP		III	III	III	III		III	III	III		III														
Kronitex® TCP		III	III	III	III		III	III	III													III	III	III	III
Kronitex® TXP		III	III	III	III		III	III														III	III	III	III
Reofos® TPP											III			III		III	III	III							
Reofos® 507														III		III	III	III							
Reofos® RDP				III	III			III						III		III	III	III							
Reofos® NHP new			III		III			III																	
Reofos® BAPP new														III		III	III	III							

*These products not registered in Europe

Appendix 5: Determination of the Washington State Fire Marshal

CHRISTINE O. GREGOIRE
Governor

JOHN R. BATISTE
Chief

STATE OF WASHINGTON
WASHINGTON STATE PATROL

RECEIVED
NOV 19 2008
DEPARTMENT OF ECOLOGY
OFFICE OF DIRECTOR

General Administration Building, PO Box 42600 • Olympia, WA 98504-2600 • (360) 753-6540 • www.wsp.wa.gov

November 18, 2008

Mr. Jay Manning, Director
Department of Ecology
PO Box 47600
Olympia WA 98504-7006

Dear Director Manning:

As required by RCW 70.76, the Department of Ecology (DOE) and the Department of Health (DOH) convened the members of Governor Gregoire's Fire Safety Committee on November 7, 2008. The departments presented information on safer and technically feasible alternatives to the flame retardant known as Deca-Brominated Diphenyl Ether (Deca-BDE). Alternatives were presented for two types of products: residential upholstered furniture and electronics. The departments reviewed their approach to identification of alternatives and went on to present information on the performance of these alternatives in providing for fire safety. The alternatives assessment conducted by DOE and DOH considered only those chemicals or technologies currently on the market and available to replace Deca-BDE in current products, while still maintaining fire protection.

Electronic Enclosures for TVs and Computers

Ecology and DOH identified one alternative to Deca-BDE for use in TVs and computers. Resorcinol bis(diphenyl phosphate) or RDP is less toxic than Deca-BDE and is technically feasible for use in these applications.

Rating of the flammability of plastic enclosures is a voluntary standard identified by the National Fire Protection Association (NFPA) in conjunction with the Underwriter's Laboratory (UL) which defines the specific method. The departments presented information to the Fire Safety Committee on the performance of RDP compared with Deca-BDE when used in electronic enclosures. RDP performs as well as Deca-BDE, although a different type of plastic has to be used. RCW 70.76 established that a simple majority vote of the Fire Safety Committee would be used to make a finding as to whether or not the alternative identified by the agencies meets applicable fire safety standards. **The committee unanimously found that RDP meets applicable fire safety standards.**

Residential Upholstered Furniture

For residential upholstered furniture, DOE and DOH relied on information from the Consumer Product Safety Commission (CPSC) indicating the availability of furniture design options that do not require the addition of chemical flame retardants. DOE and

DOH decided that achieving fire safety by redesign without the use of flame retardants is the best possible way to replace Deca-BDE.
Under the CPSC's proposed standard, fire safety in upholstered furniture can be achieved through the use of cover materials or barrier layers. The use of internal barrier materials may require the use of chemical flame retardants. The CPSC estimates that barriers would be used in only about 5 percent of upholstered furniture to meet the standard. Internal barriers are not required if compliant cover fabrics are used. Although the CPSC flammability standard for residential furniture has not been finalized, it is expected that design options will be available to meet any additional requirements in a final standard. **Again the committee unanimously found that design alternatives meet applicable fire safety standards.**

CONCLUSIONS

Based upon my review of the materials presented by the agencies and the findings of the Fire Safety Committee, I have determined that RDP, as an alternative to Deca-BDE in electronic enclosures, meets applicable fire safety standards. I have also determined, based on the information presented by the agencies and the findings of the Fire Safety Committee, that the design options for residential upholstered furniture meet applicable fire safety standards.

Sincerely,

Michael G. Matlick

State Fire Marshal Michael G. Matlick
Fire Protection Bureau

MGM:can
cc: Ms. Carol Kraege, Department of Ecoloty

Appendix 6: Response to Comments on the Draft Report

Public comment on the Draft Report on Alternatives to Deca-BDE in Televisions, Computers and Residential Upholstered Furniture was accepted from November 20 until December 17, 2008. Ecology received eight written comment letters and accepted oral comment during a meeting with representatives of the flame retardant manufacturing industry on December 15, 2008. Below are the agencies responses to these comments. Issues raised by one or more commenters are summarized and the commenters identified in *italics.*

Written comments were received from the following:

1. Marcia L. Hardy et al., Albermarle Corporation
2. Todd Myers, Washington Policy Center
3. Jay L. Watson, Local Hazardous Waste Management Program in King County, WA
4. Laurie Valeriano, et al. WA Toxics Coalition, WA State Nurses Association, WA Physicians for Social Responsibility, WashPIRG, People for Puget Sound
5. Mark Johnson, WA Retail Association
6. Peter Brigham, Federation of Burn Foundations
7. Jeff Turner, private citizen
8. Randy Hurlow, private citizen
9. Desikan, et al., Presentation made to Ecology on Dec. 15, 2008 by representatives from Albermarle and Supresta

The comment letters themselves are found in Appendix 7.

The comments are divided into two sections. The first responds to comments related to upholstered furniture. The second responds to comments related to electronic enclosures.

Alternatives to Deca-BDE in Residential Upholstered Furniture

1. **Comment:** Chemical alternatives to Deca-BDE in furniture should have been the focus of the assessment. *Desikan et al.*

   Response: RCW 70.76 requires that Ecology and DOH review risk assessments, scientific studies and other relevant findings to determine if a safer and technically feasible alternative to Deca-BDE is available. The statute does not define "safer". The agencies interpret safer as an alternative to the use of Deca-BDE that is less toxic, less persistent or less bioaccumulative than Deca-BDE. Ecology and DOH found that furniture manufacturers can, and have, designed furniture to achieve fire safety using inherently flame resistant fibers rather than using chemical flame retardants. The agencies determined that such approaches, if technically feasible and fire safe, are inherently safer than Deca-BDE. Since the statute requires only that we make sure that at least one safer alternative is available, we did not evaluate chemical alternatives and we make no assertion as to the relative safety of these flame retardants when used in

furniture. It is possible that one or more of the chemical alternatives available for this purpose is safer than Deca-BDE. Ecology and DOH do not have the regulatory authority to dictate what method furniture manufacturers select to maintain fire safety, i.e. redesign without the use of flame retardant chemicals or the use of a flame retardant other than Deca-BDE.

The statute does not require that the identified safer alternative be a direct substitute for Deca-BDE but does require that the alternative be "technically feasible". Ecology determined that a good indicator of technical feasibility is the presence and reasonable availability of the product on the market using the alternative. In other words, if Ecology can demonstrate that residential upholstered furniture, that employs the identified alternative to Deca-BDE, is currently on the market, the product is considered technically feasible. Research by CPSC staff indicates that Deca-BDE is not currently used in the U.S. to achieve fire safety in upholstered furniture and that many cover fabrics and barriers materials currently in use can meet the CPSC proposed standard without the addition of chemical flame retardants. Ecology and DOH relied on this work in reaching their conclusion that alternatives to Deca-BDE are technically feasible for residential upholstered furniture.

2. **Comment:** Recommending redesign has a big impact on manufacturers, including high labor costs and costs associated with changing materials. *Desikan et al.*

Response: The drafters of the statute recognized that manufacturers would need time to determine how best to comply with the standards and provided up to two years for this process to take place. The prohibition on the use of Deca-BDE in residential upholstered furniture will not become effective until January 1, 2011. Since Deca-BDE is not currently used in the U.S. to achieve fire safety in upholstered furniture, we do not anticipate the need for product redesign, or any costs associated with such redesign. In addition, CPSC staff research finds that most manufacturers are not interested in use of chemical flame retardants due to consumer concerns and many fabrics in use today can meet both smolder and open flame tests without addition of chemical flame retardants. Lastly, Ecology and DOH do not have the regulatory authority to require furniture manufacturers to redesign their furniture to eliminate the use of flame retardants while maintaining fire safety. Ecology and DOH have only identified redesign as a viable alternative available to furniture manufacturers.

3. **Comment:** Relying on the proposed CPSC rule for upholstered furniture represents a step backwards in fire safety. *Desikan et al.*

Response: The commenter is concerned that the CPSC proposed rule is less stringent than the current California fire safety standard described in California Technical Bulletin 117 (TB 117). The California standard, which has been adopted by a number of other state and local jurisdictions, drives the design of many products on the market today. This standard includes an open flame test for cover materials and foams used in upholstered furniture. CPSC staff indicate that all cover fabrics in use today can meet the TB 117 open flame test because it is an easy standard to meet. And since Deca-BDE

has never been used to provide fire safety for foam, it is reasonable to conclude that fire safety will not be impacted by a prohibition on the use of Deca-BDE for this application. TB 117 does not include barriers as a method to achieve fire safety as is used in the proposed CPSC standard.

CPSC received a number of comments on its proposed rule concerned that the standard should include an open flame test for cover fabrics and for foam. However, CPSC staff indicate that 90% of all fire related deaths and 75% of all fire related property damage stem from cigarettes. Therefore, to keep costs down for manufacturers and address the biggest risks, the CPSC draft rule only includes a smolder test for cover materials. A smolder test is meant to mimic a burning cigarette, while an open flame test is meant to mimic sources such as candles. The CPSC proposed rule also includes open flame and smolder tests for barriers for those manufacturers who wish to use barrier materials to provide fire safety. This information was presented to the Fire Safety Committee who found the agencies reliance on the options identified by the CPSC for their proposed CPSC rule appropriate.

The agencies evaluated the design alternatives available under the proposed CPSC flammability standard for furniture. Under the proposed standard, there are many existing cover fabrics without flame retardants that could comply with the standard by complying with the smolder test. If the proposed CPSC flammability standard were changed to include an open flame test for cover fabrics, there are still some cover fabrics that could comply and manufacturers might instead choose to use internal barriers similar to those being used currently for mattresses.

4. **Comment:** Relying on barriers will not achieve fire safety. Only 5% of upholstered furniture is projected to use this approach and most use would be in designer or high end furniture for which the relatively higher cost of barriers would not be a significant factor. *Hardy et al.*

Response: As the commenter states, only a few manufacturers may choose to provide fire safety through the use of barrier materials. The draft report concludes that "the use of internal barrier materials may require the use of chemical flame retardants" and that "there are currently design options" available that can meet the proposed standard without the addition of flame retardants. This section of the report has been changed to more clearly state that Ecology and DOH do not recommend barriers over cover materials as a method to provide for fire safety of upholstered furniture. As pointed out previously, many cover materials currently in use can provide fire safety without the use of added chemical flame retardants. The proposed CPSC rule would allow use of chemical flame retardants, but their use is not required.

According to CPSC staff, furniture manufacturers are moving away from the use of chemical flame retardants. There are existing fabrics that could meet the proposed CPSC standard without redesign, especially synthetic and synthetic blends. If manufacturers decide to use non-compliant fabrics to meet the proposed standard, they can choose to use internal barriers. Barrier methods are available and are currently

being used in mattresses to comply with the CPSC mattress flammability standard. Some barriers are made with inherently flame retardant materials. These same types of barriers could be used in upholstered furniture.

5. **Comment:** The NRC, CPSC and the EU determined that Deca-BDE does not present a health risk to consumers. *Desikan et al., Hardy et al.*

   Response: The assessments done by the NRC, CPSC and the EU to evaluate the health risks associated with Deca-BDE are out of date. These assessments relied on older toxicity data and did not consider the breakdown of Deca-BDE. EPA recently re-evaluated the toxicity of Deca-BDE and published their results in the new EPA IRIS file for deca-BDE.[65] EPA's toxicity value for deca-BDE is more protective (lower) than the toxicity value used in the NRC and CPSC evaluations indicating that toxicity is anticipated to occur at lower doses. Additionally, the purpose of the CPSC assessment was to specifically evaluate Deca-BDE exposures and health risks from its use in furniture only. It did not assess exposures or health risks from other sources of deca-BDE or its breakdown products.

Alternatives to Deca-BDE in Televisions and Computers

6. **Comment:** Ecology and DOH did not base this evaluation on credible scientific evidence. *Hardy et al.*

   Response: Ecology and DOH do not agree with this assertion. The agencies based their evaluation of alternatives to Deca-BDE on available information from authoritative sources and scientific articles published in reputable, peer-reviewed journals. Examples of such sources include information published by the Danish Ministry of the Environment and the European Commission as well as a review of toxicity studies and modeling of toxicity and environmental fate done for the agencies by Syracuse Research Corp. SRC provides similar services for EPA's Design for the Environment Program.

   The purpose of this report was to specifically explore whether or not safer alternatives are available for two specific uses of Deca-BDE. The task given to Ecology and DOH by the legislature was to find at least one alternative for each use that is safer than Deca-BDE rather than to reassess the safety of Deca-BDE which was detailed extensively in the PBDE Chemical Action Plan. The agencies evaluated the alternatives based on the definition of PBTs (WAC 173-333). Based on this evaluation, safer alternatives were identified that do not meet the definition of PBT.

[65] EPA, 2008. EPA IRIS file for BDE-209 (CASRN 1163-19-5). Available at: http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0035

7. **Comment:** The evaluation arbitrarily and capriciously excluded halogenated flame retardants from consideration as alternatives to Deca-BDE in electronic enclosures. *Hardy et al.*

Response: Ideally, Ecology and DOH would have evaluated all of the potential alternatives in detail, but such an effort is beyond the scope of the statute and beyond the resources of the agencies. If one alternative can be found that is less toxic, technically feasible and meets fire safety standards, the law states that prohibition of use of Deca-BDE in these products is appropriate.

The number and variety of flame retardants currently in use is extensive, therefore Ecology began this assessment with an effort to narrow the focus of the evaluation down to those chemical flame retardants most likely to exhibit desirable characteristics. Ecology identified several different classes of flame retardants including brominated, chlorinated, and phosphorous based flame retardants.

Several of the halogenated flame retardants have been recognized as persistent, bioaccumulative and toxic (PBT) compounds and identified as chemicals of concern. For example, in addition to PBDEs, four other halogenated flame retardants (hexabromocyclododecane, tetrabromobisphenol A, pentachlorobenzene and hexabromobiphenyl) are listed as PBTs by the Washington State PBT rule. Tris(2-chloroethyl) phosphate and Tris(2-chloro-1-methylethyl) phosphate have been identified as chemicals of concern by the European Union.

A similar comparison was made of common phosphate flame retardants such as resorcinol bis(diphenylphosphate) (RDP), triphenylphosphate (TPP) and bisphenol A diphosphate (BAPP or BADP). These chemicals were found to not persist in the environment and RDP was found to have moderate potential to bioaccumulate. For example, information provided to the European Union by Supresta, a manufacturer of RDP, states:

> '*...it is clear that the substance is only moderately concentrating (100>BCF>1000) using state of the art model calculations. The low BCF estimate, together with the ultimate biodegradability and hydrolytically instability makes that Fyrolflex RDP is <u>not</u>* [emphasis in original document] *anticipated to bio-accumulate to any significant extent.'*

This information agrees with the biodegradation summary in the EU's IUCLID dataset which states:

> '*…Fyrolflex RDP was degraded 37% in 28 days and 66% by day 56. It is thus classified as inherently biodegradable (1) valid without restriction*.'

Supresta estimated the half-life of RDP to be 40 days in fresh water and 17 days in water at 20º C and pH 7. Its partitioning coefficient (log Kow) is estimated to be 4.93.[66] In addition, studies conducted in Europe on TPP found that between 40 to 70% of TPP is degraded during the waste water treatment process. Similar studies have shown that as much as 98% of Deca-BDE does not degrade during similar processes. Therefore all else being equal, the impact of phosphorous based flame retardants on human health of the environment is less than Deca-BDE simply because they are less likely to persist and bioaccumulate. This is supported by information provided by the manufacturers (quoted above) who state that RDP does not persist and is only moderately bioaccumulative.

Based upon this information, Ecology and DOH focused on phosphorous based flame retardants. It is important to note that neither Ecology nor DOH has the authority to require manufacturers to use a specific flame retardant nor can we direct manufacturing processes. Although halogenated flame retardants were removed from this evaluation because of PBT concerns, manufacturers should review toxicity information on all flame retardants to determine which have the lowest impact on human health and the environment while maintaining fire safety.

8. **Comment:** Alternatives to use of Deca-BDE in HIPS should have been included in the assessment. *Hardy et al.*

Response: The alternatives assessment conducted by Ecology and DOH considered only those chemicals or technologies currently on the market and available to replace Deca-BDE in current products, while still maintaining fire protection. Ideally, Ecology and DOH would have evaluated all of the potential alternatives in detail, but such an effort is beyond the scope of the statute and beyond the resources of the agencies. If one alternative can be found that is less toxic, technically feasible and meets fire safety standards, the prohibition on use of Deca-BDE in these products is considered appropriate. Therefore, the agencies did not limit their search to direct substitutes, but instead evaluated whether or not the products in question could feasibly be manufactured without using Deca-BDE.

9. **Comment:** BAPP was excluded from consideration as an alternative to Deca-BDE because of concerns about Bisphenol A, "yet Ecology's recommendation to use RDP will increase the use of bisphenol A through the use of a resin based on bisphenol A. *Hardy et al.*

Response: Ecology and DOH acknowledge that one of the alternatives to High Impact Polystyrene (HIPS), which has traditionally been used to manufacture electronic enclosures, is a polycarbonate based upon bisphenol A (PC) mixed with HIPS. If this were the only alternative to HIPS, Ecology and DOH would have serious concerns about possible degradation products from PC/HIPS. However, several sources have identified polyphenylene oxide (PPO)/HIPS blends as an alternative to HIPS.

[66] Supresta, 2007. Environmental summary – bioaccumulation of Fyrolflex RDP.

HIPS/PPO blends can be successfully flame retarded using RDP and may pose less risk than the use of polycarbonate blends. The commenter correctly points out the dilemma that faces both the industry and the agencies: it is not a simple task to understand the possible unintended consequences of any action. In this case, the agencies are asserting that the risks posed by continuing use of Deca-BDE warrant its prohibition in household products because there is a safer alternative, namely RDP, which can be used in HIPS/PPO. Ecology and DOH encourage manufacturers to consider the composition of the plastic as well as the flame retardant when designing their products.

As indicated earlier, Ecology and DOH have no authority to dictate to manufacturers which plastics and flame retardants they must use, only to determine that a safer alternative exists before implementing the ban on Deca-BDE. Ecology and DOH strongly recommend that manufacturers review the toxicity of all components in the products they sell and make a concerted effort to select those chemicals which, while maintaining fire safety, have the lowest impact on human health and the environment.

10. **Comment:** Deca-BDE is not a PBT according to the definition in WAC 173-333. *Hardy et al., Washington Policy Center*

Response: Hardy et al. state that Deca-BDE does not meet the PBT criteria established in the PBT rule. In addition to a chemical's persistence, ability to bioaccumulate and toxicity, WAC 173-333 requires that Ecology consider both the parent chemical and its degradation products when making decisions about whether or not a chemical should be considered a PBT. In the case of Deca-BDE, breakdown products include Penta- and Octa-BDE. Manufacture of these two chemicals was voluntarily phased out because of their strong PBT characteristics. This issue was debated extensively during preparation of the PBDE Chemical Action Plan. For more information the reader may refer to the response to comment on the Draft PBDE CAP – Ecology publication No. 06-07-014.

11. **Comment:** The report declares that RDP, "a substance that is potentially toxic and bioaccumulative" is a suitable alternative for Deca-BDE, a chemical that is "persistent but neither toxic nor bioaccumulative. *Hardy et al.*

Response: Ecology and DOH do not agree with this statement. Deca-BDE is classified as a PBT in Washington State (see response to comment no. 6) and as such is to be avoided if possible. For more information on data used to determine the impacts of Deca-BDE, the reader may refer to the response to comment on the Draft PBDE CAP – Ecology publication No. 06-07-014.

Laboratory toxicity studies of RDP and modeling of its toxicity by Syracuse Research Corp. do suggest some toxicity albeit at much lower levels than what has been observed for Deca-BDE. The agencies acknowledge that there are data gaps for RDP toxicity testing, but the available data indicates it has lower toxicity than Deca-BDE.

The commenters point out that the Syracuse Research Corp. shows that RDP is estimated to have a bioconcentration factor of between 1000 and 5000 which exceeds

the limits established in WAC 173-333. More recent data from a manufacturer of RDP submitted to the European Union states that:

> '*...it is clear that the substance [Fyrolflex RDP] is only moderately concentrating (100>BCF>1000) using state of the art model calculations. The low BCF estimate, together with the ultimate biodegradability and hydrolytically instability makes that Fyrolflex RDP is* <u>*not*</u> [emphasis in original document] *anticipated to bio-accumulate to any significant extent.'*

This information was not available to Ecology, DOH or the Syracuse Research Center when the PBDE CAP was finalized in 2006.

In addition, the same report evaluated the acute toxicity of Fyrolflex RDP to three aquatic organisms (*daphnia magna, danio rerio and pseudokirchneriella subcapitata*). In all three tests, Fyrolflex RDP was found to have no impact upon the aquatic organisms at the 10 and 100 mg/L levels used in the tests. These tests meet stringent European requirements and support Ecology's conclusions that RDP is not persistent, only slightly bioaccumulative and has low aquatic toxicity.

It is important to note that RDP has some toxicity and has not been exhaustively tested. Based upon our review, all of the flame retardants evaluated have some documented toxicity concerns. However, as indicated by the information mentioned above, RDP is a 'safer' alternative to Deca-BDE because it:

1. Does not persist in the environment.
2. Is less likely to bioaccumulate than Deca-BDE and its degradation products.
3. Is less toxic than Deca-BDE and its degradation products to human health and the environment.

Until fire safe plastics or non-toxic chemical flame retardants are available, the best option is to focus on identifying the least toxic alternatives that can provide fire safety. Compared with Deca-BDE and its degradation products, RDP and its degradation products have less of an impact on human health and the environment and therefore meet the requirements of the legislation as a 'safer' alternative

12. **Comment:** RDP is not a safe alternative because it's breakdown product, resorcinol, has significant aquatic toxicity. – *Hardy et al.*

Response: As mentioned previously, all of the flame retardants reviewed were found to have some negative impact upon human health and the environment. Ecology and DOH reviewed the toxicity of resorcinol and, although not negligible, it was found to be less toxic than Deca-BDE and its degradation products. For example, the aquatic toxicity of resorcinol was reviewed using data published in EPA's Ecotoxicity database (ECOTOX) and NIH's Hazardous Substances database (HSDB). These results were compared with the ecotoxicity of Deca-BDE and its potential degradation products using data from the European Union's Risk Assessment Report.

Based upon this comparison, Deca-BDE and its degradation products were identified as having a high potential for aquatic toxicity while resorcinol was determined to have comparatively medium to low potential. In terms of aquatic toxicity, RDP was identified as a 'safer' alternative to Deca-BDE. Similar comparisons were also completed using human toxicity criteria and RDP, although not free of concern, was identified as 'safer'.

Although we have identified RDP as a 'safer' alternative to Deca-BDE, both Ecology and DOH encourage manufacturers to develop alternatives which are even safer than RDP. New flame retardants or inherently flame resistant plastics are needed which minimize long-term impacts to human health and the environment while maintaining fire safety.

13. **Comment:** There is no information indicating levels of Deca-BDE in humans are increasing. *Hardy et al.*

    Response: NHANES unfortunately did not include Deca-BDE in their recent biomonitoring of PBDEs in the general U.S. population.

    Many PBDE biomonitoring studies have not included Deca-BDE because of analytical difficulties and other reasons. Data from biomonitoring studies for other PBDEs have reported increasing levels in the U.S. population based on non-representative samples (e.g. Schecter et al., 2005) and have reported increasing maximum concentrations (Johnson-Restrepo et al., 2005).

14. **Comment:** "Deca-BDE is unlikely to contribute significantly to the total PBDE concentration" as demonstrated by the NHANES work. *Hardy, et al.*

    Response: NHANES unfortunately did not include Deca-BDE in their biomonitoring of PBDEs in the general U.S. population.

    Many PBDE biomonitoring studies have not included Deca-BDE because of analytical difficulties and other reasons. Data from biomonitoring studies for other PBDEs have reported increasing levels in the U.S. population based on non-representative samples (e.g. Schecter et al., 2005) and have reported increasing maximum concentrations (Johnson-Restrepo et al., 2005).

15. **Comment:** Lorber (2007) does not support the conclusion that Deca-BDE is building up in the environment. *Hardy, et al.*

    Response: The agencies acknowledge this comment and have made changes to the text of the report to address this. Ecology and DOH considered not only the build-up of Deca-BDE but also the impact the potential degradation products of Penta- and Octa-BDE have upon the environment. Degradation products of Deca-BDE are extremely bioaccumulative and persistent; therefore, the restriction of Deca-BDE is warranted.

Recent research has also indicated an increase presence of deca-BDE in the environment and additional information in this area will be added to the report. More details on this issue are available in the Response to Comments received on the PBDE CAP.

16. **Comment:** When compared to the IRIS reference dose for Deca-BDE, the maximum intake from dust is *de minimis*. *Hardy et al.*

Response: According EPA's draft exposure assessment for PBDEs and a previous publication by Lorber (2007) cited in the report, Deca-BDE is identified as a major contributor to exposure via house dust. Exposure to house dust is identified as the main human pathway of exposure to PBDEs and Deca-BDE has been identified as one of the main congeners in house dust (see studies summarized in Table 4.1 EPA draft PBDE exposure assessment report). Degradation of Deca-BDE to lower PBDE congeners in the home may also contribute to total PBDE exposures.

17**. Comment:** Credible scientific information is not cited for Ecology's conclusion that TPP is present at low levels in RDP therefore its impact on the environment is expected to be low. TPP has significant aquatic toxicity. *Hardy et al*.

Response: Ecology and DOH considered this issue during the evaluation process. TPP does have significant aquatic toxicity which is one of the primary reasons it was not selected as a safer alternative to Deca-BDE. TPP is present in RDP mixtures at a maximum of 5% based upon a Material Safety Data Sheet from Chemtura for its product Reofos RDP. As such it contributes to the toxicity of RDP and was included in the evaluation process. Strictly on a mass balance approach, however, TPP's contribution is small to the overall toxicity of the RDP mixture. RDP constitutes >95% of the mixture and is the primary driver for any toxicity concerns. Ecology and DOH used data available from EPA's High Production Volume Challenge on the toxicity of RDP and several sources for the toxicity of TPP.

In addition, as mentioned in earlier, TPP is readily degraded in the environment and does not bioaccumulate. European studies have shown that 40-70% of TPP is degraded during the waste water treatment process. Therefore although it has similar toxicity concerns as Deca-BDE, TPP's long-term impact to human health and the environment is less and it is intrinsically 'safer' as its impacts would not persist as is the case with a PBT like Deca-BDE.

18**. Comment:** The report does not contain enough new information to justify a different conclusion from the one made in the CAP. There is still insufficient information to evaluate the toxicity of RDP. *Washington Policy Center*

Response: The agencies acknowledge that there are still data gaps in information about RDP. However, there has been additional information provided to the agencies since the CAP to help us decide that RDP is a safer alternative. The review of toxicity information and modeling data provided in the report by the Syracuse Research Corp. highlights the lower toxicity of RDP compared to Deca-BDE. Additional information

about the persistence and bioaccumulation of RDP confirms the agencies previous findings that RDP is not a PBT. Reports published since completion of the CAP (by Maine DEP and CDC, Illinois Dept. of Environmental Protection, and Clean Production Action), have analyzed alternatives to Deca-BDE using different methods and have all come to similar conclusions about RDP as a preferable, safer alternative given the available information.

19. **Comment:** The conclusion that RDP is less toxic than Deca-BDE is based on a lack of information rather than positive information that RDP is truly less toxic. *Washington Policy Center, Local Hazardous Waste Management Program of King County*

Response: The agencies acknowledge that RDP does lack some toxicity data. However, based on available toxicity studies and other information provided in the report, the agencies find that it is a safer alternative.

20. **Comment:** Use of modeling data (such as the SRC and Clean Production Action reports) rather than experimental data means our conclusion that RDP is safer has a large margin of error *Washington Policy Center*

Response: Ecology and DOH agree that experimental data would be useful data for evaluating the toxicity of RDP. Unfortunately, few toxicity studies are available for RDP. It turns out that this scenario is common for many of the flame retardants on the market today. The agencies decided to use modeling data to fill in some of the toxicity data gaps. Models and approaches such as structure activity analysis can be a reasonable indicator of potential problems. For example, using models to predict the toxicity of chemicals is one of the main ways companies can comply with the new EU REACH regulations. The US EPA also uses modeling extensively to determine toxicity for untested compounds. Ecology and Health acknowledge that there is not perfect information for RDP but that existing information indicates that it is not a PBT and is therefore "safer" than Deca-BDE.

21. **Comment**: Ecology "appears to lean toward 'precaution' when it comes to Deca-BDE but gives RDP the benefit of the doubt when information is lacking". *Washington Policy Center*

Response: The commenter points out one of the challenges we face when trying to identify safer alternatives when we lack perfect data. The agencies have demonstrated that ongoing use of Deca-BDE leads to build up of Deca-BDE in the environment and in people and that the breakdown of Deca-BDE provides an ongoing source of exposure to Penta and Octa-BDE[67]. As a result, as the commenter correctly points out, the agencies have already decided that the use of Deca should be phased out per the PBDE CAP. . Again, the commenter is correct when he states that there are data gaps related to the evaluation of RDP. Because of this, the agencies encourage manufacturers to continue to search for other alternatives that have more testing data and that are safer than RDP.

[67] Washington State Polybrominated Diphenyl Ether (PBDE) Chemical Action Final Plan, January 19, 2006. Department of Ecology publication no. 05-07-048.

Nevertheless, based on our analysis, RDP has been determined to be safer than Deca-BDE because it is significantly less persistent and less toxic, especially when the breakdown products are considered. For more information on response to concerns about RDP breakdown products, see the response to Comment # 9 above.

22. **Comment:** Ecology should stand behind its conclusions by "assuming the liability for subsequent impacts from RDP". *Washington Policy Center*

Response: Ecology cannot assume liability for the choices of manufacturers any more than the agency can dictate the manufacturing processes. The purpose of this report is to establish that at least one safer alternative is available to manufacturers. Neither Agency can require the use of RDP or of any specific plastic with or without flame retardants. Beyond that, manufacturers are encouraged to know what is in their products and what the risks are before placing products on the market.

23. **Comment:** Ecology should refuse to certify that RDP is a suitable alternative to Deca-BDE OR Ecology should conduct a cost-benefit analysis of RDP against Deca-BDE. *Washington Policy Center*

Response: As stated above, Ecology cannot "certify" or require that certain materials be used to provide for fire safety in televisions and computers. Such a certification is beyond our authority and these decisions should (and do) rest with the manufacturers. The role of Ecology and DOH in this process was to identify at least one safer alternative to Deca-BDE so that policy makers would know that manufacturers do have options. We do not want to place manufacturers in a position where the only choice is a chemical that is as problematic or worse, than Deca-BDE.

A cost benefit analysis is not called for in statute. In addition, Ecology has found that traditional cost benefit analyses for these issues are not particularly helpful in making decisions due to the lack of information available on valuation of health benefits. However, given the current use of RDP in electronic enclosures, and the lack of use of Deca-BDE in residential upholstered furniture, the agencies have concluded that RDP is a feasible and reasonably available alternative.

24. **Comment:** Requiring manufacturers to switch from Deca-BDE to RDP will force significantly higher operating costs on business which is not warranted in this case. *Jeff Turner, Randy Harlow, Washington Retail Association*

Response: The drafters of the statute recognized that manufacturers would need time to determine how best to comply with the standards and provided up to two years for this process to take place. The prohibition on the use of Deca-BDE in televisions, computers and residential upholstered furniture will not become effective until January 1, 2011. Also, Ecology and DOH do not have the regulatory authority to require manufacturers to use specific plastics or design strategies. Ecology and DOH have only identified viable alternatives available to manufacturers.

Ecology and DOH understand that concerns about impacts to businesses are important. However the Legislature banned Deca-BDE because of the serious impacts the flame retardant has upon human health and safety and the environment. Deca-BDE has already been banned in Maine and in the European Union and businesses in neither have reported a negative impact. While conducting this review, Ecology and DOH specifically contacted counterparts in Maine and asked about potential negative impacts from their decision to ban Deca-BDE and were informed that none have been identified. To our knowledge, no concerns have been expressed in Europe where the ban on use of Deca-BDE in electronics went into effect on July 1, 2008. In fact, many businesses indicate that they have already removed brominated flame retardants from their products including Deca-BDE and have stated so in their corporate policy.

The comment, however, does identify a very important issue which Ecology and DOH will clarify in the report. Ecology and DOH are not requiring businesses to use RDP in place of Deca-BDE. This report deals solely with the banning of Deca-BDE in specific products and the identification of a safer alternative. The legislation does not give Ecology and DOH the authority to dictate the use of any specific alternative nor is it the agency's intent to dictate the use of RDP. Additional toxicity information is desirable for all flame retardants currently in use. Additional work is needed to identify chemicals or processes which have minimal impact upon human health and the environment while maintaining fire safety.

25. **Comment:** There is insufficient data to show that RDP is safer and easier to use. *Washington Retail Association*

Response: Ecology and DOH do not agree. Both agencies recognize that data gaps exist for all chemicals reviewed during this process. This decision is based on the best data available at this time. Both agencies believe that sufficient data exist to show that RDP and its degradation products are, at a minimum, less persistent, bioaccumulative and less toxic than Deca-BDE and its degradation products.

As mentioned in the previous comment, Ecology and DOH are not requiring businesses to use RDP in place of Deca-BDE nor are we dictating what plastics and flame retardants are used in electronic enclosures. Ecology and DOH, however, recommend that manufacturers closely review the toxicity of the chemicals they use in their products before proceeding.

26. **Comment:** Postpone the adoption of the alternatives report until a more thorough review can be conducted to ensure both safety and ease of compliance. *Washington Retail Association*

Response: Ecology and DOH found that RDP is safer than Deca-BDE,.though the agencies recognize that RDP exhibits some toxicity and does bioaccumulate to a moderate degree. The agencies considered "ease of compliance" as part of the determination that RDP was feasible for use in televisions and computers. The finding that RDP was feasible for use in these products is rooted in the fact that these products

are already on the market and that RDP is used to provide fire safety. Finally, the law provides two years for companies to adjust to this prohibition on the use of Deca-BDE.

27. **Comment:** WTC supports the agency's findings. "Companies are moving to safer alternatives and clearly demonstrating their availability in the market place." *Washington Toxics Coalition*

Response: Comment noted

28. **Comment:** The state should evaluate flame retardants as a class of chemicals and address other problematic flame retardants in the near future. *Washington Toxics Coalition*

Response: Ecology has identified the next two chemicals for which a CAP will be conducted. These are polycyclic aromatic hydrocarbons and perfluoro-octane sulfonates. Once these two CAPs are completed, Ecology will again assess the PBT list and determine which chemicals require a plan. At that time, Ecology will consider whether flame retardants as a class of chemicals can be considered simultaneously.

29. **Comment:** Two commenters expressed support for the findings of the Report. *Local Hazardous Waste Management Program of King Count, Brigham*

Response: Comment noted

30. **Comment:** The report does not clearly articulate whether the degradation of BAPP to bisphenol A is sufficient to cause it to be eliminated from consideration. Information on the extent of degradation should be included. *Local Hazardous Waste Management Program of King County*

Response: Ecology and DOH agree with the concern identified by this comment. However given the increased attention to the possible impacts to human health and the environment, Ecology and DOH did not wish to recommend a compound such as BAPP as a 'safer' alternative when information on exposure and degradation is not available. Ecology and DOH want to clarify that neither agency is recommending the replacement of Deca-BDE solely with RDP. As additional information becomes available about flame retardants (FRs), it may be that other FRs are equally or even potentially less toxic than RDP. However, given the information available at the time this report was written, Ecology and DOH believe RDP is at least one safer alternative to Deca-BDE. Ecology and DOH have received other similar comments which indicate the report is not clear concerning this recommendation.

31. **Comment:** There are data gaps in the characterization of the toxicity and environmental fate of RDP. *Local Hazardous Waste Management Program of King County*

Response: The amount of information concerning toxicity and environmental fate for all of the alternative flame retardants (FRs) is incomplete. However, the potential

human health and environmental impacts of Deca-BDE are well documented and we were tasked to identify a 'safer' alternative. With the information currently available for the alternatives to Deca-BDE, Ecology and DOH find that phosphate based flame retardants are inherently less harmful to the environment than brominated alternatives such as Deca-BDE because they are not PBTs. The information currently available indicates that phosphorous FRs are not persistent and only mildly bioaccumulative while brominated FRs such as Deca-BDE are both. For example, several studies have been conducted on the degradation of TPP at waste water treatment plants and as much as 40-70% of the TPP is degraded during the treatment process while 98% of the Deca-BDE remains untouched. Therefore even if the impacts to human health and the environment for phosphorous FRs are less known, their tendency to break down in the environment make them a lower exposure risk over their lifespan. In addition, Ecology and DOH are not recommending RDP for use in lieu of Deca-BDE only that RDP appears based on current information to be a 'safer' alternative. Ecology and DOH will clarify this point in the report.

Appendix 7: Comment Letters

December 17, 2008

Carol P. Kraege
Department of Ecology
Washington State
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RE: Public Comments on Denise LaFlamme and Alex Stone (November 20, 2008). *Alternatives to Deca-BDE in televisions, computers and residential upholstered furniture. Implementation of RCW 70.76: identifying safer and technically feasible alternatives to the flame retardant called Deca-BDE used in the electronic enclosures of televisions and computers and in residential upholstered furniture. Draft.* State of Washington, Department of Ecology Publication No. 08-07-062, Department of Health Publication No. 334-181, pp. 1-59. URL: http://www.ecy.wa.gov/pubs/0807062.pdf

Dear Ms. Kraege:

Attached please find our timely submission of public comments on the above draft document. Our main points are:

- The Draft does not meet the requirements of the RCW 70.76 for identifying the availability of safer, technically feasible alternatives to decabromodiphenyl ether (Deca-BDE) and cannot be used to support a ban on Deca-BDE.
- For televisions and electronic enclosures, the Draft declares a substance that is potentially toxic and bioaccumulative, *e.g.*, resorcinol bis(diphenyl phosphate) or RDP, as a suitable alternative for one that is persistent but neither toxic nor bioaccumulative (*i.e.,* Deca-BDE).
- For an alternative to Deca-BDE in textiles, the Draft proposes a technology (barriers) that the U.S. Consumer Product Safety Commission projects would be used in 5% of upholstered furniture with most of that in designer/higher-priced furniture where the higher cost of barriers are not a factor.
- The Draft is not based on credible scientific information as required by WAC 173-333 *et seq*, and overlooks or incorrectly reports conclusions presented in credible documents or studies (*e.g.*, EU RAR Deca-BDE, *etc*), including the conclusions from a report Ecology commissioned from Syracuse Research Corporation.
- The Draft is biased, inconsistent, and reaches conclusions that are arbitrary and capricious. The Draft excluded a major class of flame retardants (halogenated) from consideration as potential alternatives without providing the credible scientific information that Ecology used to make this determination. The Draft excluded a potential alternative flame retardant (BAPP) because it was based on bisphenol A, yet recommends a flame retardant (RDP) that requires a switch to a bisphenol A-based resin. The Draft concluded that Deca-BDE is persistent, yet raised concerns about possible breakdown products.

The enclosed comments provide supporting documentation to the above statements, and our commitment that credible scientific information supports the safety of Deca-BDE. All information has been key cited in order to ensure transparency with the process.

Should you have any questions or comments, please feel free to contact us at your convenience. We thank you for the opportunity to comment on this document.

Respectfully,

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//enclosure

cc: Jay J. Manning, Director, Washington State Department of Ecology
Mary C. Selecky, Secretary of Health, Washington State Department of Health

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COMMENTS ON DRAFT PUBLICATION No. 08-07-062[1]

The Revised Code of Washington (RCW) 70.76 lays out a process for identifying the availability of safer, technically feasible alternatives to decabromodiphenyl ether (Deca-BDE) that meet fire safety standards for Deca-BDE's applications. The law requires that when safer alternatives are identified, the manufacture, sale, or distribution of upholstery and electronic enclosures containing Deca-BDE in Washington State will be prohibited two years from the date of identification. The State of Washington's Departments of Ecology (hereinafter "Ecology") and Health (DOH) reviewed various information on alternatives in their Draft Publication No. 08-07-062, and concluded technically feasible, safer alternatives to Deca-BDE are available, *e.g.*, triphenyl phosphate (TPP), bisphenol A diphenyl phosphate (BAPP), and resorcinol bis(diphenyl phosphate) (RDP). Effect levels in animal studies and aquatic toxicity information on the three chemicals were compared. TPP was eliminated based on a concern for aquatic toxicity.[2] BAPP was excluded because "[r]ecent concern about the risks posed by bisphenol A suggests that more information is needed before this flame retardant can be considered as a safer alternative to Deca-BDE".[3] RDP was found to be a safer and technically feasible alternative to Deca-BDE in televisions and computers.[4] Ecology and DOH determined that textile fire safety can be achieved by redesign without the use of flame retardants (or other chemicals).[5] Based on this, restrictions on Deca-BDE will take effect on January 1, 2011.

The Draft Publication No. 08-07-062 on alternatives to Deca-BDE is fundamentally flawed. Draft Publication No. 08-07-062 accepts and repeats conclusions drawn by others without further evaluation, overlooks or incorrectly reports conclusions presented in credible documents, does not base its evaluation on credible scientific information as required by state law,[6] and is biased against a major class of flame retardants. As such, Draft Publication No. 08-07-062 does not fulfill the requirements of RCW 70.76 and cannot be used to justify restrictions on Deca-BDE. Moreover, Draft Publication No. 08-07-062 identifies, as an alternative for televisions and computers, a substance (*i.e.*, RDP) with potentially greater hazards than Deca-BDE. With respect to upholstery textiles, Draft Publication No. 08-07-062 proposes using barriers as an alternative to Deca-BDE, and bases this recommendation on Ecology's conclusion that the United States (U.S.) Consumer Product Safety Commission's (CPSC's) 2008 proposed flammability standard for residential upholstered furniture does not rely on the use of flame retardants.[7] While the proposed CPSC standard does not **require** the use of flame retardants,

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[1] Denise LaFlamme and Alex Stone (November 20, 2008). *Alternatives to Deca-BDE in televisions, computers and residential upholstered furniture. Implementation of RCW 70.76: identifying safer and technically feasible alternatives to the flame retardant called Deca-BDE used in the electronic enclosures of televisions and computers and in residential upholstered furniture. Draft.* Washington State, Department of Ecology Publication No. 08-07-062, Department of Health Publication No. 334-181, pp. 1-59. URL: http://www.ecy.wa.gov/pubs/0807062.pdf (accessed December 14, 2008).

[2] *Id.* at p. 9.

[3] *Id.* at p. 24.

[4] *Id.* at p. 9.

[5] *Id.* at p.10.

[6] WAC (2006). *Persistent bioaccumulative toxins.* Washington Administrative Code, Chapter 173-333, pp. 1-17, *et seq*. URL: http://www.ecy.wa.gov/pubs/wac173333.pdf (accessed December 14, 2008).

[7] LaFlamme and Stone, *supra* note 1, at p. 18.

neither is their use prohibited.[8] Further, the barrier approach favored in Draft Publication No. 08-07-062 is only a small part of CPSC's proposed standard. CPSC stated: "[b]arriers are projected to be used in only about 5% of all upholstered furniture; most of this usage would be in designer or higher-priced furniture for which the relatively higher cost of barriers would not be a significant factor.[9] Thus, Draft Publication No. 08-07-062 assessment of alternatives to Deca-BDE in upholstery textiles is inadequate.

In brief, Draft Publication No. 08-07-062 declares a substance that is potentially toxic and bioaccumulative as a suitable alternative for one that is persistent but neither toxic nor bioaccumulative.

Some of the flaws in the Draft Publication No. 08-07-062 are addressed in the following; however, due to time constraints, we were unable to provide corrections for all inaccuracies. Further, a comparison of the persistence, bioaccumulation, and toxicity of Deca-BDE and RDP is provided; human exposures and environmental loading are also addressed. With respect to upholstery textiles, both the U.S. National Research Council (NRC)[10] and the CPSC[11] determined Deca-BDE did not present a health risk to the consumer.

BIAS RESULTING IN ARBITRARY AND CAPRICIOUS FINDINGS.

Draft Publication No. 08-07-062 demonstrates its bias against a major class of flame retardants by not considering any halogenated flame retardant as a potential alternative to Deca-BDE. A brominated flame retardant (BFR) is the most technically feasible and cost effective alternative to Deca-BDE in consumer electronics. A flame retardant's mechanism of action must match a resin's burn characteristics to bring about the reduction in fire hazard. Thus, another BFR is the most technically feasible alternative to Deca-BDE, but none were considered. As Draft Publication No. 08-07-062 correctly states, to utilize a non-halogenated flame retardant in Deca-BDE's applications (*e.g.*, high impact polystyrene), the resin must be substituted as well.

Ecology excluded BAPP from its review in Draft Publication No. 08-07-062 because it is synthesized using bisphenol A; however, Ecology's recommendation for substituting RDP for Deca-BDE will require the use of PC/ABS (*i.e.*, polycarbonate/acrylonitrile/butadiene/styrene

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[8] CPSC (2008). *Standard for the flammability of residential upholstered furniture*. Federal Register, Vol. 72, pp. 11702-11752, at p. 11709.

[9] *Id.*

[10] NRC (2000). *5 Decabromodiphenyl oxide*. In: *Toxicological risks of selected flame-retardant chemicals*. National Research Council, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee of Flame-Retardant Chemicals, pp. 72-98. URL: http://books.nap.edu/openbook.php?record_id=9841&page=72 (accessed December 14, 2008). See also: Bill Kearney and Megan O'Neill (April 27, 2000). *Eight flame-retardant chemicals can safely be used on upholstered furniture*. News - The National Academies - Advisors to the Nation on Science, Engineering, and Medicine. URL: http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=9841 (accessed December 14, 2008).

[11] Babich MA and Thomas TA (2001). *CPSC staff exposure and risk assessment of flame retardant chemicals in residential upholstered furniture*. U.S. Consumer Product Safety Commission, Bethesda, MDBut see: CPSC (2005) *Nomination of FR chemicals for NTP testing*, http://ntp.niehs.nih.gov/index.cfm?objectid=E50FA099-F1F6-975E-7FFC8239D3BF04B1, pp. 1-17, at p. 4 (accessed December 14, 2008) (Note: subsequent recommendations from the CPSC were made based on the flawed work of Viberg *et al.*, 2003; *infra* note 58).

blend) plastics, which are synthesized using bisphenol A. Therefore, Ecology has refused to evaluate BAPP because it is synthesized from bisphenol A, yet Ecology's recommendation to use RDP will increase the use of bisphenol A through the use of a resin based on bisphenol A. Draft Publication No. 08-07-062 does not consider what effect this substitution in resin will have on Washington State.

Further, Draft Publication No. 08-07-062 avoided halogenated flame retardants as alternatives "[b]ecause halogenated flame retardants are more likely to persist in the environment and to bioaccumulate in organisms".[12] However, Ecology concluded that at least three halogenated flame retardants out of seven evaluated were not persistent bioaccumulative toxins (PBTs), yet arbitrarily chose not to evaluate the three chemicals as alternatives to Deca-BDE.[13] Further, Draft Publication No. 08-07-062 provides no evidence to back up their claim that halogenated flame retardants are more likely than other types to be persistent or bioaccumulative.

RELIANCE ON FLAWED DOCUMENTS. OVERLOOKING OR INCORRECTLY REPORTING CONCLUSIONS PRESENTED IN CREDIBLE DOCUMENTS/STUDIES.

Draft Publication No. 08-07-062 identified Deca-BDE as a "persistent, bioaccumulative toxic chemical",[14] based on its listing in Chapter 173-333 (*Persistent Bioaccumulative Toxins*) of Washington Administrative Code (WAC).[15] WAC 173-333 defines chemicals as PBT when the following criteria for persistence, bioaccumulation, and toxicity are met:[16]

> "(a) **Persistence.** The chemical or chemical group can persist in the environment based on credible scientific information that: (i) The half-life of the chemical in water is greater than or equal to sixty days; or (ii) The half-life of the chemical in soil is greater than or equal to sixty days; or (iii) The half-life of the chemical in sediments is greater than or equal to sixty days; and
> (b) **Bioaccumulation.** The chemical or chemical group has a high potential to bioaccumulate based on credible scientific information that the bioconcentration factor or bioaccumulation factor in aquatic species for the chemical is greater than 1,000 or, in the absence of such data, that the log-octanol water partition coefficient (log K_{ow}) is greater than five; and
> (c) **Toxicity.** The chemical or chemical group has the potential to be toxic to humans or plants and wildlife based on credible scientific information that: (i) The chemical (or chemical group) is a carcinogen, a developmental or reproductive toxicant or a neurotoxicant; (ii) The chemical (or chemical group) has a reference dose or equivalent toxicity measure that is less than 0.003 mg/kg/day; or (iii) The chemical (or chemical group) has a chronic no observed effect concentration (NOEC) or equivalent toxicity measure that is less than 0.1 mg/L or an acute no observed effect concentration (NOEC) or equivalent toxicity measure that is less than 1.0 mg/L".

WAC 173-133 requires that "credible scientific information" be used to make PBT determinations. Credible scientific information is defined as "...information that is based on a theory or technique that is generally accepted in the relevant scientific community or has been

[12] LaFlamme and Stone, *supra* note 1, at p. 13.
[13] Denise Laflamme (October 25, 2005). *Alternatives to Deca-BDE.* PBDE Advisory Committee Meeting, pp. 1-25, at p. 17.
[14] *Id.* at p. 18.
[15] WAC (2006), *supra* note 6, at p. 8.
[16] *Id.* at p. 10.

collected or derived using standard or generally accepted methods and protocols and appropriate quality assurance and control procedures".[17]

Deca-BDE's toxicology results are derived from credible studies (*e.g.*, compliance with international guidelines and Good Laboratory Practice (GLP) standards, and/or reviewed by national/international agencies) and indicate it does not meet the above PBT criteria. Deca-BDE is persistent in the environment, but it is not bioaccumulative [measured fish bioconcentration factor (BCF) < 50][18] and is not toxic [No-Adverse-Effect-Level ≥ 1,000 mg/kg-day in repeated dose studies].[19] Deca-BDE is not a mutagen,[20] is not a listed carcinogen by the U.S. National Toxicology Program's (NTP's) *Report on Carcinogens*,[21] the U.S. Occupational Safety and Health Administration (OSHA),[22] the International Agency for Research on Cancer (IARC),[23] or the European Union (EU).[24] Deca-BDE did not affect the reproductive system[25] or fetal development[26] in repeated dose studies. The NRC and the U.S. Environmental Protection Agency's (EPA's) Integrated Risk Information System (IRIS) derived chronic oral reference values for Deca-BDE of 4 mg/kg-day[27] and 0.007 mg/kg-day, respectively.[28] The U.S. Agency for Toxic Substances and Disease Registry (ATSDR) derived an intermediate-duration minimal risk level (MRL) of 10 mg/kg-day.[29] Deca-BDE is not acutely toxic to aquatic organisms (*i.e.*, fish, algae, *Daphnia*) at the limit of its water solubility,[30] and is not expected to be toxic to

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[17] *Id.* at p. 4.

[18] Hardy ML (2002). *The toxicology of the three commercial polybrominated diphenyl oxide (ether) flame retardants*. Chemosphere, Vol. 46, pp. 757-777, at p. 759.

[19] *Id.*

[20] NTP (1986). *Toxicology and carcinogenesis studies of decabromodiphenyl oxide (CAS No. 1163-19-5) in F344/N rats and B6C3F$_1$ mice (feed studies)*. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, Technical Report Series, No. 309, pp. 1-242, at p. 12. URL: http://ntp.niehs.nih.gov/ntp/htdocs/LT_rpts/tr309.pdf (accessed December 14, 2008).

[21] NTP (2005). *Report on carcinogens, eleventh edition*. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program. URL: http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932 (accessed December 14, 2008).

[22] 29 CFR §1910.1003. *13 carcinogens (4-nitrobiphenyl, etc.)*. URL: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10007&p_table=STANDARDS (accessed December 14, 2008).

[23] IARC (1990). *IARC monographs on the evaluation of carcinogenic risks to humans – Some flame retardants and textile chemicals and exposures in the textile manufacturing industry*. IARC Monographs Vol. 48, pp. 1-345, at p. 82.

[24] EU RAR (2002). *European Union risk assessment report - Bis(pentabromophenyl) ether - CAS No: 1163-19-5 - EINECS No: 214-604-9*. European Commission – Joint Research Centre, Institute for Health and Consumer Protection, European Chemicals Buremu, European Union Risk Assessment Report, EUR 20402 EN, Series 1st Priority List, Vol. 17, pp. 1-294, at p. 149. URL: http://ecb.jrc.it/DOCUMENTS/Existing-Chemicals/RISK_ASSESSMENT/REPORT/decabromodiphenyletherreport013.pdf (accessed December 14, 2008).

[25] *Id.* at pp. 149-152.

[26] Hardy *et al*. (2002). *Prenatal oral (gavage) developmental toxicity study of decabromodiphenyl oxide in rats*. International Journal of Toxicology, Vol. 21, pp. 83-91.

[27] NRC (2000), *supra* note 10.

[28] IRIS (2008). *2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE-209) (CASRN 1163-19-5)*. URL: http://www.epa.gov/ncea/iris/subst/0035.htm (accessed December 14, 2008).

[29] ATSDR (2004). *Appendix A. ATSDR minimal risk levels and worksheets*. In: *Toxicological profile for polybrominated biphenyls and polybrominated diphenyl ethers (PBBs and PBDEs)*. Intermediate oral MRL, at p. A-14. URL: http://www.atsdr.cdc.gov/toxprofiles/tp68-a.pdf (accessed December 14, 2008).

[30] EU RAR (2002) *supra* note 24, at p. 97.

aquatic organisms on chronic exposure.[31] Testing in earthworms ($NOEC_{survival\ and\ reproduction} \geq$ 4,910 mg/kg dry soil), sediment organisms ($NOEC_{nominal} \geq$ 5,000 mg/kg sediment dry weight), sludge microorganisms (NOEC $\geq$ 15 mg/L) and terrestrial plants ($NOEC_{nominal} \geq$ 6,250 mg/kg dry soil) also demonstrates a lack of toxicity.[32]

Deca-BDE does not fulfill Washington State's definition of a PBT substance. Draft Publication No. 08-07-062's reliance on Deca-BDE's PBT listing in Chapter 173-333 WAC *Persistent Bioaccumulative Toxins* is not based on credible scientific information and is therefore flawed.

EVALUATION NOT BASED ON CREDIBLE SCIENTIFIC INFORMATION AS REQUIRED BY STATE LAW.

There is no indication in Draft Publication No. 08-07-062 that Ecology and DOH made any attempt to assess the quality of the studies on which they relied. In contrast, the Deca-BDE studies and risk assessments cited above were conducted under accepted guidelines, GLPs and/or were evaluated by international agencies. Note that RCW 70.76 requires that Ecology and DOH review risk assessments, scientific studies and other relevant findings regarding Deca-BDE alternatives in residential upholstered furniture, televisions, and computers.

Though Deca-BDE and RDP are not PBTs based on the criteria set forth in WAC 173-333-320, Ecology's determination that RDP is a suitable alternative to Deca-BDE is based their compiling studies on Deca-BDE, rather than analyzing the relevance of the studies for use in risk assessment, as is required to meet Washington State's standard of "credible scientific information". For example, Ecology cited to and summarized peer-reviewed studies as support that Deca-BDE degrades in the environment (their primary basis for classifying Deca-BDE as a PBT);[33,34] however, the credible scientific information standard of WAC 173-333 *et seq* applies only to the studies themselves, not to Ecology's conclusions based on a mere listing of those studies. In order to meet the credible scientific information standard, Ecology must provide analyses of the studies cited and an assessment of the data quality and relevance of the studies to risk assessment. The EU performed an evaluation of this type, thus the EU's risk assessment process is "...based on a theory or technique that is generally accepted in the relevant scientific community", and therefore, meets the standard of "credible scientific information" as required by WAC 173-333 *et seq*. This approach is consistent with data quality and relevance standards used by the EPA, the Organization for Economic Cooperation and Development (OECD), and the EU.[35,36]

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[31] *Id.*
[32] *Id.* at pp. 96, 97, 100, and 110.
[33] WA (2006). *Washington State polybrominated diphenyl ether (PBDE) Chemical Action Plan: Final plan.* Washington State, Department of Ecology Publication No. 05-07-048, Department of Health Publication No. 334-079, pp. 1-310, at pp. 113-118. URL: http://www.ecy.wa.gov/pubs/0507048.pdf (accessed December 14, 2008).
[34] LaFlamme and Stone, *supra* note 1, at pp. 18-19.
[35] Klimisch *et al.* (1997). *A systematic approach for evaluating the quality of experimental toxicological and ecotoxicological data.* Regulatory Toxicology and Pharmacology, Vol. 25, pp. 1-5.
[36] EPA (2003). *A summary of general assessment factors for evaluating the quality of scientific and technical information.* U.S. Environmental Protection Agency, Science Policy Council, EPA 100/B-03/001, pp. 1-11.

HAZARDS OF RDP.

Ecology relied on an evaluation of RDP performed by Syracuse Research Corporation (SRC) under contract to the department.[37] SRC reported RDP was not persistent,[38] had moderate potential for bioaccumulation (*e.g.*, BCF between 1,000 and 5,000),[39] had inadequate mammalian toxicology data on which to base an assessment, and was a "*high*" concern with respect to aquatic toxicity.[40] Though RDP is not persistent, it fulfills Washington State's criteria for classifying a chemical as bioaccumulative and toxic.

We point out that SRC's assessment of RDP's aquatic toxicity is reflected in the EU's classification and labeling which lists resorcinol, an RDP breakdown product, as "R50: Very toxic to aquatic organisms".[41]

Draft Publication No. 08-07-062 also errs in reporting SRC's conclusions on RDP. Draft Publication No. 08-07-062 states RDP and its breakdown products have a "*medium*", "*medium-low*" or "*low*" risk of acute or chronic toxicity, and a moderate concern for bioconcentration. However, Draft Publication No. 08-07-062 does not indicate that this "*moderate*" concern for bioconcentration fulfills Washington State's definition of bioaccumulation, nor does it correctly reflect that RDP is a high concern for aquatic toxicity.

Thus, Draft Publication No. 08-07-062 recommends replacement of a flame retardant (Deca-BDE) that is persistent but not bioaccumulative or toxic, with one (*i.e.*, RDP) that is not persistent but which is both bioaccumulative and toxic.

Deca-BDE AND RDP COMPARED.

1. Persistence.

SUBMITTERS' CONCLUSION: Deca-BDE is Persistent; RDP is not persistent.

Bases for conclusion on Deca-BDE:
The EU's Risk Assessment Report on Deca-BDE stated the following: "[t]he rate of degradation of decabromodiphenyl ether under aerobic and anaerobic conditions appears to be very low".[42]

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[37] SRC (2006). *Flame retardant alternatives (An assessment of potential health and environmental impacts of RDP and BAPP, two phosphate-based alternatives to Deca-BDE for use in electronics.* Conducted by Syracuse Research Corporation for the Washington State Departments of Ecology and Health, February 2006, pp. 1-258.
[38] *Id.* at p. 25.
[39] *Id.*
[40] *Id.*
[41] ESIS. Classification Risk Phrases for CAS# 108-46-3. European Commision Joint Research Centre, European Chemical Substances Information System. URL: http://ecb.jrc.ec.europa.eu/esis (accessed December 14, 2008).
[42] EU RAR (2002), *supra* note 24, at p. 56.

Further, the EU evaluated the available studies, which investigated the potential of Deca-BDE to degrade to lower brominated compounds *via* photodegradation and biodegradation (aerobic and anaerobic). The EU concluded:

> …there is some evidence that [Deca-BDE] may photodegrade in the environment under certain conditions, but it is not possible to estimate the rate or extent of this reaction. [Deca-BDE] is predicted to adsorb strongly onto sediment and soil and only a fraction of this, that exposed to sunlight, will have the potential to photodegrade. Thus, although photodegradation of [Deca-BDE] is a possibility, the rate of reaction will be assumed to be effectively zero for environmental modelling purposes.[43]
>
> The rate of biodegradation will be assumed to be effectively zero for environmental modelling purposes.[44]

It is noteworthy that the EU evaluated the available degradation studies on Deca-BDE for data quality and relevance for risk assessment. For example, the EU properly assessed the relevance of degradation studies performed under laboratory conditions, which "…are intended to maximise the exposure (*e.g.* by use of thin surface films of the substances)".[45] In contrast to, "…the environment, where [Deca-BDE] is likely to be adsorbed to bulk matrices, only a small fraction of that present (*i.e.* that near the exposed surface) may be susceptible to photodegradation".[46]

As indicated above, when data are assessed based on quality and relevance, degradation of Deca-BDE is "effectively zero" in the environment. Therefore, based on the criteria set forth in WAC 173-333-320, Deca-BDE is expected to be persistent in the environment; however, it is not expected to degrade to lower brominated compounds.

Bases for conclusion on RDP:
Ecology determined that RDP is not persistent.[47] This determination is consistent with the evaluation performed by SRC under contract to Ecology.[48]

2. Bioaccumulation

SUBMITTERS' CONCLUSION: Deca-BDE does not bioaccumulate; RDP **B**ioaccumulates.

Bases for conclusion on Deca-BDE:
The EU concluded the following about Deca-BDE's potential to bioaccumulate in aquatic organisms:[49]

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[43] *Id.* at p. 56.
[44] *Id.*
[45] *Id.* at p. 48.
[46] *Id.* at pp. 48-49.
[47] LaFlamme and Stone, *supra* note 1, at p. 47.
[48] SRC (2006), *supra* note 37, at p. 25.
[49] EU RAR (2002), *supra* note 24, at p. 62.

> Overall, it can be concluded that, although there is some experimental evidence that decabromodiphenyl ether can be taken up by aquatic organisms via food, only a very small proportion of the total dose was taken up (~0.02-0.13% over 120 days) and so the substance can be considered to have a low bioaccumulation potential.

The NTP conducted a disposition study with Deca-BDE in male rats and reported:

> ...[A]fter exposure at all doses in the diet, greater than 99% of the radioactivity recovered was excreted in the feces within 72 hours. Excretion in urine accounted for approximately 0.01% or less of the dose. After a dose was administered intravenously, 61% of the recovered radioactivity was excreted in feces in 72 hours and approximately 0.1% was excreted in urine.[50]
>
> A study of decabromodiphenyl oxide absorption from the gastrointestinal tract indicated that absorption was minimal, possibly less than 1%, at the doses administered in the 2-year studies.[51]

Based on the foregoing credible scientific information, Deca-BDE is not bioaccumulative.

Bases for conclusion on RDP:

Ecology states "[b]ased on criteria in Ecology PBT Rule, neither RDP nor its main breakdown products would qualify as a PBT in Washington".[52] SRC evaluated the potential of RDP to bioaccumulate using the following criteria:[53]

Concern Level	Bioaccumulation Criteria
High	BCF > 5,000
Moderate	BCF between 1,000 and 5,000
Low	BCF < 1,000

SRC classified RDP as a "*moderate*" concern level for bioconcentration.[54,55] Therefore, using the criteria set forth in WAC 173-333-320, RDP is bioaccumulative.

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[50] NTP (1986), *supra* note 20, at p. 52.
[51] *Id.* at p. 11.
[52] LaFlamme and Stone, *supra* note 1, at p. 25.
[53] SRC (2006), *supra* note 37, at p. 8 (Table 2-3, modified for this comment).
[54] *Id.* at p. 25.
[55] RDP has an estimated BCF of 2,956. *Cf.* Deca-BDE has an estimated BCF of ~3.2. *See*: BCF Program (v2.17), EPA (2007) Estimation Programs Interface Suite™ for Microsoft Windows® XP/XP Professional®. U.S. Environmental Protection Agency, Washington, D.C.

3. Toxicity

SUBMITTERS' CONCLUSION: Deca-BDE presents a low concern level for toxicity to mammals and aquatic organisms; RDP presents a moderate concern level for toxicity to mammals, but is **T**oxic to aquatic organisms.

Bases for conclusion for Deca-BDE's mammalian toxicity:

Ecology cite to the EPA's IRIS health assessment on Deca-BDE as support that this compound causes "neurodevelopmental and reproductive toxicity in animal studies with toxic effects as low as 6.7 mg/kg".[56] The IRIS health assessment on Deca-BDE provided summaries of five studies, which evaluated developmental and reproductive endpoints.[57] The experimental design used in two of these studies[58,59] was deemed "unacceptable" by a peer-review panel co-sponsored by the EPA.[60] The design also violated fundamental norms in developmental toxicology, as identified and reported by other peer-review panels assembled by the EPA and/or the U.S. National Institute of Environmental Health Sciences (panel reports published as Haseman *et al.*, 2001; Zoetis and Walls, 2003; and Moser *et al.*, 2005; See also: Holson and Pearce, 1992).[61,62,63,64] Therefore, these two studies (*i.e.*, Viberg *et al.*, 2003; Viberg *et al.*, 2007) fail to meet the standard required for "credible scientific information" in WAC 173-333 *et seq*. It is noteworthy that the study (*i.e.*, Viberg *et al.*, 2007; note 59) for which Ecology relies on as presenting toxicity data "as low as 6.7 mg/kg" is one of the two, which employed the faulty experimental design. The remaining three studies (*i.e.*, Hardy *et al.*, 2002; Tseng *et al.*, 2006; and Rice *et al.*, 2007)[65] warrant discussion.

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[56] LaFlamme and Stone, *supra* note 1, at p. 18 (Footnote 8).

[57] EPA (2008). *Toxicological review of decabromodiphenyl ether (BDE-209) (CAS No. 1163-19-5).* U.S. Environmental Protection Agency, Washington, D.C. pp. 1-126, at p. 29 (Table 4-3). URL: http://www.epa.gov/ncea/iris/toxreviews/0035-tr.pdf htm (accessed December 14, 2008).

[58] Viberg *et al.* (2003). *Neurobehavioral derangements in adult mice receiving decabrominated diphenyl ether (PBDE 209) during a defined period of neonatal brain development*, Toxicological Sciences, Vol. 76, pp. 112-120.

[59] Viberg *et al.* (2007). *Changes in spontaneous behaviour and altered response to nicotine in the adult rat, after neonatal exposure to the brominated flame retardant, decabrominated diphenyl ether (PBDE 209)*, Neurotoxicology, Vol. 28, pp. 136-142.

[60] Holson *et al.* (2008). *Statistical issues and techniques appropriate for developmental neurotoxicity testing – A report from the ILSI Research Foundation/Risk Science Institute expert working group on neurodevelopmental endpoints.* Neurotoxicology and Teratology, Vol. 30, pp. 326-348, at p. 335. See also: Johansson *et al.* (2008). *Neonatal exposure to deca-brominated diphenyl ether (PBDE 209) causes dose-response changes in spontaneous behaviour, cholinergic susceptibility in adult mice.* Neurotoxicology, doi: 10.1016/j.neuro.2008.09.008. This study employed the exact experimental design rejected by Holson *et al.* (2008), as well as, the reports in notes 15-18 and fails to meet the standard for "credible scientific information" as defined by WAC 173-333-200.

[61] Holson and Pearce (1992). *Principles and pitfalls in the analysis of prenatal treatment effects in multiparous species.* Neurotoxicology and Teratology, Vol. 14, pp. 221-228.

[62] Haseman *et al.* (2001). *Statistical issues in the analysis of low-dose endocrine disruptor data.* Toxicological Sciences, Vol. 61, pp. 201-210.

[63] Zoetis and Walls (2003). *5 - Data interpretation.* In: *Principles & practices for direct dosing of pre-weaning mammals in toxicity testing and research.* I. Zoetis and T. Walls (Eds.), ILSI Press, Washington, D.C., pp. 1-93, at pp. 61-63.

[64] Moser *et al.* (2005). *Direct dosing of preweaning rodents in toxicity testing and research: deliberations of an ILSI RSI Expert Working Group.* International Journal of Toxicology, Vol. 24, pp. 87-94.

[65] Rice *et al.* (2007). *Developmental delays and locomotor activity in the C57BL6/J mouse following neonatal exposure to the fully-brominated PBDE, decabromodiphenyl ether.* Neurotoxicology and Teratology, Vol. 29, pp. 511-520, at pp. 512-513.

To evaluate developmental exposures to the commercially available form of Deca-BDE (97.34% Deca-BDE, 2.66% nona- and octabromodiphenyl ether congeners), Hardy *et al.* (2002) conducted a guideline compliant prenatal developmental toxicity study[66] performed in accordance with GLP standards.[67] This study meets the "credible scientific information" standard required by WAC 173-333 *et seq*. In this study, female Sprague Dawley rats (25 mated females/group) received 0, 100, 300 or 1,000 mg Deca-BDE/kg-day *via* gavage in corn oil from gestation day 0-19. All dams survived until scheduled sacrifice. No clinical signs of toxicity were observed. Pregnancy rates in the control and treated groups ranged from 96-100% and provided 23 or more litters in each group for evaluation on gestation day 20. No effect of treatment was detected in maternal gestational parameters (body weight, body weight gain and food consumption), uterine implantation data, liver weight or necropsy findings. Likewise, no treatment-related effects were detected in fetal body weights, fetal sex distribution, or from the fetal external, visceral, or skeletal examinations. The NOEL (No Observable Effect Level) for maternal and developmental toxicity was 1,000 mg Deca-BDE/kg-day, the highest dose level tested.

In a study aimed at identifying Deca-BDE-induced reproductive toxicity, Tseng *et al.* (2006)[68] gavaged male CD-1 mice from postnatal day (PND) 21 until PND 70 with Deca-BDE (98% purity; corn oil vehicle). A total of 50 male pups were divided into five groups consisting of 10 pups for each of the corresponding dose levels: 0, 10, 100, 500, or 1,500 mg/kg-day. The authors used littermates, rather than litters, as the statistical and experimental unit. No attempt was made to control for litter effects. Therefore, Tseng *et al.* (2006) does not meet the 'credible scientific information' standard as required by WAC 173-333 *et seq*., and as required in studies of this type (*See* notes 15-18). No treatment-related effects were observed for bodyweight, reproductive organ weight (*e.g.*, testis, epididymis, cauda epididymis, and seminal vesicles), sperm properties (*e.g.*, motility, velocity and morphology), or testis DNA content (*i.e*, cell frequencies of mature haploid, immature haploid, diploid, tetraploid, as well, as S-phase). Histopathology of testes from treated and control animals were indistinguishable from one another. The authors reported a lowest-observed-adverse-effect level of 500 mg/kg-bw, based on statistically significant changes in sperm velocity of motion (one parameter out of five), sperm count with high mitochondrial membrane potential (MMP), and sperm with elevated levels of hydrogen peroxide. Despite the authors' conclusion, the biological significance of these findings are unclear and likely the result of variation due to a failure to control for litter effects, given that the subchronic and chronic studies conducted by the NTP did not observe changes in the testes of rats or mice exposed to Deca-BDE at doses exceeding the levels and duration used by Tseng *et al*. (2006).[69,70]

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[66] This study was compliant with the EPA's Office of Pollution Prevention and Toxic Substances (OPPTS) guideline No. 870.3700, and the Organization for Economical Cooperation and Development (OECD) guideline study No. 414.

[67] This study was conducted in accordance with the EPA's Toxic Substances Control Act (TSCA) Good Laboratory Practice Standards (40 CFR Part 792), and OECD Principles of Good Laboratory Practice [C(97)186 (Final)].

[68] Tseng *et al.* (2006). *Postnatal exposure of the male mouse to 2,2',3,3',4,4',5,5',6,6'-decabrominated diphenyl ether: decreased epididymal sperm functions without alterations in DNA content and histology in testis.* Toxicology, Vol. 224, pp. 33-43.

[69] NTP (1986), *supra* note 20.

Rice *et al.* (2007)[71] evaluated the effects of postnatal exposure to Deca-BDE on parameters of growth and development, ontogeny of growth and development, and motor activity in male and female mice. The authors concluded that administration of Deca-BDE (20 mg/kg-day on PND 2-15) to neonatal mice produced the following: i) developmental delays in the acquisition of the palpebral reflex, ii) a dose-related reduction of serum thyroxine levels in immature males, iii) altered sex- and age-specific characteristics of spontaneous locomotor activity with the most striking effect being an increase of activity during the first 1.5 h of the 2 h assessment in males, and iv) that "[t]hese effects suggest that [Deca-BDE] is a developmental neurotoxicant that can produce long-term behavioral changes following a discrete period of neonatal exposure". The authors did not report significant effects on responses to handling while being removed from homecage, color of mucous membranes, eyes, and skin, bizarre movements, gait abnormalities, rearing, righting reflex, approach response, palpebral closure, startle response, tail pinch, or touch response.

Several methodological and statistical issues exist with the endpoints for which Rice *et al.* (2007) claim to be affected by treatment. First, although Rice *et al.* (2007) state that specific parameters were statistically significantly affected, no statement was made about the p-value from which the statistical results were to be compared.

Second, Rice *et al.* (2007) reported that acquisition of palpebral reflex, forelimb grip, and struggling during handling, were components of the Functional Observational Battery (FOB) and were examined using repeated-measures analysis of variance (ANOVA) with Newman-Keuls post hoc tests. However, ANOVAs have underlying distribution assumptions that may or may not be compatible with the use of scored data, thus non-parametric tests should have been used, especially since Rice *et al.* (2007) stated the following:

> The FOB measures consisted of discrete categories, with the assigned scores for defined behaviors being arbitrary, *such that averaging the scores provided no meaningful indication of effects* [emphasis added]. Therefore, the score or scores associated with the normal or mature pattern of behavior was identified for each endpoint (Table 1). Scores for abnormal behaviors were also scrutinized. These were low or absent in most but not all cases.[72]

Rice *et al.* (2007) did not provide the scoring system used, nor did they state in the publication whether they evaluated their data using a non-parametric statistic, which as noted above, is typically used for scored data. Requests for individual animal data were submitted to the first

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[70] See also: Norris *et al.* (1975). *Toxicology of octabromobiphenyl and decabromodiphenyl oxide.* Environmental Health Perspectives, Vol. 11, pp. 153-161, at p. 159. Though not cited by IRIS, Norris *et al.* (1975) published a summary of a one-generation reproduction study using a lower purity form of Deca-BDE (*i.e.*, Dow FR-300-BA; 77.4% Deca-BDE, 21.8% nonaBDE, and 0.8% octaBDE). The authors concluded "[t]he reproductive capacity of rats was not affected by diets providing 100, 30, or 3 mg/kg-day of [lower purity Deca-BDE] given for 90 days prior to mating as well as during mating, gestation and lactation. The per cent and number of pregnancies, pup survival indices, neonatal body weights, male/female ratio on day 21, and the length of time between the first day of cohabitation and delivery were not affected by the inclusion of [lower purity Deca-BDE] in the diets".

[71] Rice *et al.* (2007), *supra* note 65, at p. 511.

[72] Rice *et al.* (2007), *supra* note 65, at pp. 512 – 513.

and corresponding authors of Rice *et al.* (2007); however, the first author's supervisor stated "[the first author] has never had custody or possession of individual animal data".[73] The corresponding author provided group animal data, but claimed the request for individual animal data was "unduly burdensome".[74]

Third, palpebral reflex is only appropriate once eyes are fully open, and according to Table 1 of Rice *et al.* (2007), "[c]losure was normal from PND 16-20 with some evidence of eyelid droop or closure in both sexes on PND 14". The authors reported that percent of pups in the 20 mg/kg-day dose group performing the palpebral reflex were statistically significantly different (p = 0.04) from controls on PND 14. Thus, evaluating palpebral reflex on PND 14 is inappropriate for determining a treatment-related outcome.

Fourth, Rice *et al.* (2007) stated "[t]rend analysis indicated that the slope of the linear function for the males was significantly different from zero [$F(1,24)=5.72$, $P=0.03$; Fig. 4]".[75] Essentially, Rice *et al.* reported mean T_4 levels in the control and two treatment groups and fit them to a line and compared the slope of the line to the abscissa. When the group animal data[76] were evaluated using a one-way ANOVA followed by a Newman-Keuls post hoc test, no statistically significant differences were found ($p > 0.05$) (*See* data in Attachment 1).

Finally, Rice *et al.* (2007) stated "...the rate of decline was significantly different in exposed compared to control animals as indicated by a main effect of exposure on the linear slope parameter [$F(2,29)=3.60$, $P=0.04$; Fig. 5]. Post hoc tests indicated that the 20 mg/kg/day group was significantly different from the control group, an effect that was the most pronounced in the males during the first 1.5 h of the 2 h activity session [$P<0.5$ for 15-min time blocks 1, 3, 4, and 5]".[77] Rice *et al.* (2007) fit the motor activity data to a linear model, rather than comparing values between controls and treated animals within each time block, as was done by Viberg *et al.*, 2003, 2007. When the male PND 70 data from Rice *et al.* (2007) were analyzed by one-way analysis of variance (ANOVA) with Newman-Keuls post hoc test, no statistically significant differences ($p > 0.05$) were found between treated animals and the respective controls at each time point (*See* data in Attachment 1).

Based on the foregoing information, Rice *et al.* (2007) fails to meet the standard of "credible scientific information" as required by WAC 173-333 *et seq.*

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[73] Smith, A.E. (2007). Electronic mail dated August 15, 2007; from: Andy E. Smith; to: Marek Banasik; cc: Vincent Markowski, Nancy Bearsdley, Marina Thibeau, Deborah Rice, Paul Gauvreau; Subject: RE: FOIA request for Individual Animal Data for Rice et al. Study.

[74] Markowski, V. (2008). Letter dated June 20, 2008; from: Vince Markowski, Associate Professor of Psychopharmacology; to: Lliam Harrison, Director of Research Compliance; cc: Devinder Malhotra, Dean of the College of Arts and Sciences and Deborah Johnson, Psychology Department Chair.

[75] Rice *et al.* (2007), *supra* note 65, at p. 517.

[76] Based on group animal data received from the corresponding author of Rice *et al.* (2007). Male mice T_4 % same sex control: Group 1(controls) - mean = 100.01, SD = 10.61, n = 8; Group 2 (6 mg/kg-day group) - mean = 92.05, SD = 18.78, n = 11; Group 3 (20 mg/kg-day group) - mean = 79.01, SD = 17.58, n = 6.

[77] Rice *et al.* (2007), *supra* note 65, at p. 516.

In the EU's Risk Assessment Report on Deca-BDE, the following conclusion was drawn for workers, consumers, humans exposed *via* the environment, and human health (risks from physico-chemical properties):

> There is at present no need for further information and/or testing and no need for risk reduction measures beyond those which are being applied already.[78]

The above determination was made after the EU critically reviewed the extensive mammalian toxicology database that exists for Deca-BDE. A summary of the mammalian toxicology endpoints evaluated by the EU, and the EU's conclusions about the adequacy of these study data is provided in Table 1.

Table 1. EU conclusions on the mammalian toxicology data for Deca-BDE

Toxicological Endpoint	*EU conclusions on data adequacy*
1) acute oral toxicity;[79]	"[Deca-BDE] exhibits a low acute oral, dermal and inhalation toxicity".[80]
2) acute dermal toxicity;[81]	
3) acute inhalation toxicity;[82]	
4) eye irritation;[83]	"[Deca-BDE] is not an irritant for skin or eyes".[84]
5) dermal irritation;[85]	
6) skin sensitization;[86]	"Taking into account the negative results from studies in animals on [octabromodiphenyl ether] and in regard with the two quite large human studies reported on [Deca-BDE], this substance can be considered as a non skin sensitizer".[87]
7) subacute/subchronic oral toxicity (14-day, 28-day, and 90-day);[88]	"The subchronic and chronic oral toxicity of [Deca-BDE] is low".[89]
8) chronic oral toxicity (2-years in rats and mice);[90]	
9) genotoxicity (*in vitro* & *in vivo*);[91]	"[Deca-BDE] does not exhibit any cytogenetic effects *in vitro* nor *in vivo*".[92]
10) carcinogenicity;[93]	"…a classification for [Deca-BDE's] carcinogenicity is not proposed".[94] *See also*: IARC found that Deca-BDE "*is not classifiable as to its*

[78] EU RAR (2002), *supra* note 24, at p. 162.
[79] *Id.* at p. 131.
[80] *Id.* at p. 132.
[81] *Id.* at pp. 131-132.
[82] *Id.* at p. 132.
[83] *Id.* at pp. 132-133.
[84] *Id.* at p. 133.
[85] *Id.* at p. 132.
[86] *Id.* at p. 134.
[87] *Id.*
[88] *Id.* at pp. 135-136.
[89] *Id.* at p. 141.
[90] *Id.* at pp. 137-141.
[91] *Id.* at pp. 141-143.
[92] *Id.* at p. 143.
[93] *Id.* at pp. 143-149.
[94] *Id.* at p. 149.

	carcinogenicity to humans (Group 3)".[95] Neither the NTP nor the OSHA list Deca-BDE as a carcinogen.
11) reproductive toxicity;[96]	"In this study [Norris *et al.* (1975), *supra* note 70], the NOAEL, which is the highest dose tested, is 100 mg/kg/day for parents and conceptus. However, a higher dose should have been tested to produce a parental toxic effect. No adverse effect on fertility was observed".[97] "In [a] study reported by NTP (1986), no macroscopic or histological changes were seen in testes, prostate, ovaries or uterus when rats and mice were treated for 13 weeks (with up to 50,000 ppm) and for two years (with up to 50,000 ppm) with [Deca-BDE] (>94% purity). Tissues were preserved in 10% neutral buffered formalin, embedded in paraffin, stained with hematoxylin and eosin; use of Bouin's fixative for these tissues would have been more appropriate".[98] "In Norris et al. (1975), no macroscopic or histological changes were observed in testes, ovaries or uterus when rats were treated with [Deca-BDE] (purity of 77.4%) for 118 days but no indications on the preservation and fixation methods are available".[99] "Concerning fertility neither the results of one generation study [Norris *et al.* (1975)] nor examination of reproductive organs in rats and mice treated for 13 weeks or two years with up to 50,000 ppm of [Deca-BDE] are indicative of an adverse effect on fertility".[100]
12) developmental toxicity;[101]	"…[B]ased on this recent prenatal developmental toxicity [study][citing Hardy *et al.* (2002), *supra* note 26], no concern for adverse effects on development may be assumed".[102]
13) immunotoxicity;[103]	"In contrast to polybrominated biphenyls, no immunotoxic properties have been identified throughout histological examination of lymphoid organs in rats and mice in the 90-day and 2 year studies [citing NTP (1986) *supra* note 20]".[104]
14) neurotoxicity;[105]	"The toxicological significance of these findings is unclear…Moreover only an abstract of this study [Viberg *et al.* (2003)] is available". But see notes 60-64, *supra*.

Bases for conclusion for RDP's mammalian toxicity:

Ecology provides a human health toxicity comparison between Deca-BDE, RDP, and TPP on pp. 43-44. Ecology states: "[t]his information is mainly taken from a review of toxicity information for RDP and TPP compiled by Syracuse Research Corporation [SRC] under contract for the

[95] IARC (1990), *supra* note 23.
[96] EU RAR (2002), *supra* note 24, at pp. 149-150.
[97] *Id.* at p. 149.
[98] *Id.* at p. 150.
[99] *Id.*
[100] *Id.* at p. 151.
[101] *Id.* at pp. 150-152.
[102] *Id.* at p. 152.
[103] *Id.*
[104] *Id.*
[105] *Id.* at pp. 153-154.

[Ecology]".[106] As shown in Table 2, SRC determined that all of the mammalian toxicity data for RDP were inadequate:

Table 2. SRC's conclusions on the mammalian toxicology data for RDP	
Toxicological Endpoint	*SRC's conclusions on data adequacy*
1) acute oral toxicity;	"The existing acute oral toxicity data were judged inadequate to meet the endpoint".[107]
2) acute dermal toxicity;	"The existing acute dermal toxicity data were judged inadequate to meet the endpoint".[108]
3) acute inhalation toxicity;	"The existing acute inhalation toxicity data were judged inadequate to meet the endpoint".[109]
4) eye irritation;	"The existing eye irritation data were judged inadequate to meet the endpoint".[110]
5) dermal irritation;	"The existing acute dermal irritation data were judged inadequate to meet the endpoint".[111]
6) skin sensitization;	"The existing skin sensitization data were judged inadequate to meet the endpoint".[112]
7) subchronic oral toxicity (28-day, 90-day, or combined reproductive/developmental);	"The existing subchronic oral toxicity data were judged inadequate to meet the endpoint."[113]
8) subchronic dermal toxicity (21/28-day or 90-day);	"The existing data were judged inadequate to meet the endpoint".[114,115,116,117,118,119,120,121,122]
9) subchronic inhalation toxicity (28-day or 90-day);	
10) reproductive toxicity;	
11) developmental toxicity;	
12) chronic toxicity;	
13) carcinogenicity;	
14) neurotoxicity;	
15) immunotoxicity;	
16) genotoxicity;	

RDP is readily metabolized by mammalian species (*e.g.*, monkeys, rats, and mice) with the major fecal and urinary metabolites consisting of free and conjugated resorcinol.[123] The World

[106] LaFlamme and Stone, *supra* note 1, at p. 42.
[107] SRC (2006), *supra* note 37, at p. 115.
[108] *Id.* at p. 116.
[109] *Id.*
[110] *Id.* at p. 117.
[111] *Id.*
[112] *Id.*
[113] *Id.* at p. 118.
[114] *Id.* at p. 120.
[115] *Id.*
[116] *Id.* at p. 121.
[117] *Id.* at p. 122.
[118] *Id.* at p. 123.
[119] *Id.*
[120] *Id.* at p. 124.
[121] *Id.* at p. 125.
[122] *Id.*
[123] IUCLID (October 26, 2001). *IUCLID data set - Phosphoryl chloride, polymer with resorcinol phenyl ester - CAS No. 125997-21-9*. European Chemicals Bureau, International Uniform Chemical Information Database, pp. 1-23, at pp. 20-21. ["This study confirms that the test substance is metabolized in an identical manner by rats, mice, and primates, and that the rat and mouse are appropriate surrogates in which to assess the toxicity of resorcinol bis(diphenylphosphate)"].

Health Organization's (WHO's) International Programme on Chemical Safety (IPCS) conducted a risk assessment on resorcinol and identified studies with LOAELs for thyroid effects as low as 5 mg/kg-day from 30- and 90-day drinking water studies in rats.[124] Further, in a chronic study in rats and mice using resorcinol as the test article, the NTP noted the following: "[c]linical signs suggestive of a chemical-related effect on the central nervous system, including ataxia, recumbency, and tremors, were observed in rats and mice in the 2-year studies".[125]

Bases for the conclusion of Deca-BDE's ecological toxicity:

Ecology summarized the aquatic toxicity for Deca-BDE as "*High*" for acute and chronic toxicity.[126] They also listed octabrominated diphenyl ether (Octa-BDE) as a "*High*" concern for acute and chronic toxicity.[127] However, as noted above, the EU concluded that Deca-BDE does not degrade in the environment and is not toxic to aquatic organisms.[128] The same findings were made for Octa-BDE.[129] However, using the criteria set forth in Chapter 173-333 WAC *Persistent Bioaccumulative Toxins*, Ecology has failed to adhere to the required standard of "credible scientific information" when making their determinations. The EU's Risk Assessment Report on Deca-BDE provides a complete risk assessment for aquatic and terrestrial species.[130] The EU concluded the following:

> "No effects on aquatic organisms are expected to occur at concentrations up to the substances water solubility".[131]
>
> "For microorganisms, a NOEC of ≥15 mg/l has been determined for decabromodiphenyl ether in an activated sludge respiration inhibition test".[132]
>
> "Decabromodiphenyl ether has been tested with *Lubriculus variegates* [a sediment-dwelling organism] in two different sediments. No effects were seen in these studies and the lowest NOEC from these studies was 3,841 mg/kg dry weight".[133]

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[124] IPCS (2006). *Concise International Chemical Assessment Document 71 - Resorcinol.* International Programme on Chemical Safety, pp. 1-72, at p. 26 (Table 7).

[125] NTP (1992). *Toxicology and carcinogenesis studies of resorcinol (CAS No. 108-46-3) in F344/N rats and B6C3F$_1$ mice (gavage studies).* U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, Technical Report Series, No. 403, pp. 1-239, at p. 6. URL: http://ntp.niehs.nih.gov/ntp/htdocs/LT_rpts/tr403.pdf (accessed December 14, 2008).

[126] LaFlamme and Stone, *supra* note 1, at p. 46.

[127] *Id.*

[128] EU RAR (2002) *supra* note 24.

[129] EU RAR (2002a). *European Union risk assessment report – diphenyl ether, octabromo derive. - CAS No: 32536-52-0 - EINECS No: 251-087-9.* European Commission – Joint Research Centre, Institute for Health and Consumer Protection, European Chemicals Buremu, European Union Risk Assessment Report, EUR 20402 EN, Series 1st Priority List, Vol. 16, pp. 1-262, at p. 39 ("The rate of biodegradation will be assumed to be effectively zero for environmental modelling purposes."), at p. 73 ("The available toxicity data for [Octa-BDE] show that no acute effects in fish or longer-term effects in *Daphnia* would be expected to occur at concentrations of [Octa-BDE] up to its solubility limit."). URL: http://ecb.jrc.ec.europa.eu/esis/ (Input CAS# 32536-52-0, then select 'view & save it' by Final RAR) (accessed December 14, 2008).

[130] EU RAR (2002) *supra* note 24, at pp. 92-106.

[131] *Id.* at p. 97.

[132] *Id.*

[133] *Id.*

> "Overall, the NOEC from these studies [evaluating the toxicity of Deca-BDE in six species of plants] was given as ≥6,250 mg/kg dry soil based on nominal values or ≥5,349 mg/kg dry soil based on the mean measured concentration in soil at the start of the test".[134]
>
> "Overall, no significant adverse effects on survival or reproduction were seen in this study [an earthworm study] and so the NOEC is ≥ 4,910 mg/kg dry weight".[135]

Bases for the conclusion of RDP's ecological toxicity:

Ecology determined that RDP and its breakdown products presented a "*Medium*", "*Med-Low*", or "*Low*" risk of acute or chronic toxicity.[136] Ecology states that the toxicity information is taken from a review performed by SRC under contract to Ecology.[137] In contrast to Ecology's ranking RDP as a "*Medium*" aquatic hazard, SRC ranked the concern level for RDP as "*High*" for aquatic toxicity and the overall hazard concern as "*High*" for aquatic organisms.[138] Under the European Commission's Classification and Labelling system, resorcinol is listed as "*R50: Very toxic to aquatic organisms*".[139] In contrast, Ecology ranks resorcinol as a "*Med-Low*" hazard for acute and chronic aquatic toxicity.[140]

HUMAN EXPOSURE

Draft Publication No. 08-07-062 states that many studies indicate an "increasing buildup of Deca-BDE" in humans. While the number of publications reporting detection of Deca-BDE has increased in recent years, no information indicates levels in humans are increasing. Further, one of the largest studies investigating human polybrominated diphenyl ether blood levels did not include Deca-BDE because "[b]ased on a NHANES 2001-2002 serum pool study the mean concentration of [Deca-BDE] is about 2 ng/g lipids in those 12 years of age and older (unpublished data); therefore, [Deca-BDE] is unlikely to contribute significantly to the total PBDE concentration".[141] Analysis of Deca-BDE is challenging and not all reports of its detection are accurate. Note, the NHANES study authors specifically stated "DecaBDE was not included in this survey due to difficulties with analytical measurement".[142]

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[134] *Id.* at p. 100.
[135] *Id.* at p. 102.
[136] LaFlamme and Stone, *supra* note 1, at p. 46.
[137] SRC (2006) *supra* note 37.
[138] *Id.* at p. 25.
[139] ESIS, *supra* note 41.
[140] LaFlamme and Stone, *supra* note 1, at p. 46.
[141] Sjödin *et al.* (2008). *Serum concentrations of polybrominated diphenyl ethers (PBDEs) and polybrominated biphenyl (PBB) in the United States population: 2003-2004.* Environmental Science and Technology, Vol. 42, pp. 1377-1384, at p. 1383.
[142] *Id.* at p. 1378.

Ecology incorrectly cites to Lorber (2007) as support that "…there is an increasing buildup of deca-BDE in the environment, in indoor environment, and in people".[143] Lorber (2007) performed an exposure assessment for polybrominated diphenyl ethers (*i.e.*, ΣBDEs-28, -47, -99, -100, -138, -153, -154, -183, and -209) based on the following exposure pathways: food and water ingestion, inhalation, and ingestion and dermal contact to house dust.[144] Lorber concluded the daily intake dose of ΣBDEs was 7.7 ng/kg-bw for adults, 49.3 ng/kg-bw for ages 1-5, 14.4 ng/kg-bw for ages 6-11, and 9.1 ng/kg-bw for ages 12-19.[145] No indication was made that "…there is an increasing buildup of deca-BDE in the environment, in indoor environment, and in people".

Citing Allen *et al.* (2008),[146] Ecology states "…recent research indicates high levels of deca-BDE in house dust and possible linkage between house dust, electronics and human exposure".[147] Though Ecology states that high levels of Deca-BDE were reported in house dust, this requires explanation. Allen *et al.* (2008) reported values up to approximately 10,000 ng Deca-BDE/g of dust.[148] When this quantity is used for calculating an intake value, maximum intakes of 300-600 ng of Deca-BDE are estimated based on the EPA's recommended values for bodyweight and dust ingestion.[149] To place these values into context, the EPA's IRIS program derived an oral reference dose[150] for Deca-BDE that equates to 64,400 - 501,200 ng/day, depending on bodyweight. Thus, the maximum Deca-BDE intake from dust, 300-600 ng/day, based on Allen *et al.* (2008), is *de minimis* compared to IRIS' reference dose, 64,400-501,200 ng/day.

ENVIRONMENTAL LOADING OF TPP AND RDP

Ecology states: "[o]ne issue worth noting is that commercial RDP contains up to 5 percent of TPP (see below). Therefore, although it is difficult to completely separate the two chemicals, it is important to look at the toxicity of the major component as this will have the greatest impact on human health and the environment. Therefore because TPP is present at low levels in RDP, its impact is expected to be low because it is a minor component".[151] It is unclear which "credible scientific information" Ecology relied upon to make the above determination that the level of TPP in RDP will not have an impact on human health and the environment. SRC ranked TPP's overall hazard concern for aquatic toxicity and mammalian toxicity as "*High*" and

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[143] LaFlamme and Stone, *supra* note 1, at p. 19.
[144] Matthew Lorber (2007). *Exposure of Americans to polybrominated diphenyl ethers.* Journal of Exposure Science and Environmental Epidemiology, Vol. 18, pp. 1-18.
[145] *Id.* at p. 8.
[146] Allen *et al.* (2008). *Linking PBDEs in house dust to consumer products using X-ray fluorescence.* Environmental Science and Technology, Vol. 42, pp. 4222-4228.
[147] LaFlamme and Stone, *supra* note 1, at p. 19.
[148] Allen *et al.* (2008), *supra* note 147, at p. 4226 (Figure 3).
[149] EPA (2008). *Child-specific exposure factors handbook.* U.S. Environmental Protection Agency, EPA/600/R-06/096F. Bodyweights for ages 6 to < 11 months = 9.2 kg, and ages 16 to < 21 years = 71.6 kg, at p. 8-2 (Table 8-1). Dust ingestion of 30 or 60 mg/day, at p. 5-5 (Table 5-1). URL: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=199243 (accessed December 14, 2008).
[150] IRIS (2008), *supra* note 28. *But see:* NRC (2000), *supra* note 10, at p. 85 (chronic oral RfD = 4.0 mg/kg-day).
[151] LaFlamme and Stone, *supra* note 1, at p. 25.

"*Moderate*", respectively.[152] Further, the U.S. Department of Transportation (DOT) requires that materials containing TPP be labeled as a "severe marine pollutant".[153]

Based on Ecology's predicted loading of RDP (*i.e.*, 588,000 kg per year) to Puget Sound, an estimated 29,400 kg of TPP per year will be introduced to this ecosystem.[154] This does not include the approximate annual load of resorcinol of ~73,000 to 90,000 kg.[155] Recall that the DOT requires materials containing TPP to carry the label as a "*severe marine pollutant*", and the European Commission requires materials containing resorcinol to carry the label "*R50: Very toxic to aquatic organisms*". In comparison, Ecology estimated 490,000 kg of Deca-BDE in products sold in Washington State in one year.[156] Thus, the annual load of RDP, the alternate identified by Draft Publication No. 08-07-062, would be greater than that of Deca-BDE, a compound, which the EU determined, does not degrade to lower brominated compounds and is not toxic to aquatic and terrestrial organisms.

SUMMARY

Draft Publication No. 08-07-062 does not meet the requirements of the RCW 70.76 for identifying the availability of safer, technically feasible alternatives to Deca-BDE, and cannot be used to justify restrictions on Deca-BDE.

For televisions and electronic enclosures, Draft Publication No. 08-07-062 declares a substance that is potentially toxic and bioaccumulative, *e.g.*, resorcinol bis(diphenyl phosphate) or RDP, as a suitable alternative for one that is persistent but neither toxic nor bioaccumulative (*e.g.,* Deca-BDE).

For an alternative to Deca-BDE in textiles, Draft Publication No. 08-07-062 proposes a technology (barriers) that the CPSC projects would be used in 5% of upholstered furniture with most of that in designer/higher-priced furniture where the higher cost of barriers are not a factor.

Draft Publication No. 08-07-062 is not based on credible scientific information as required by state law, *e.g.*, WAC 173-333 *et seq*, and overlooks or incorrectly reports conclusions presented in credible documents or studies (*e.g.*, EU RAR Deca-BDE, *etc*), including its own commissioned report from SRC.

Draft Publication No. 08-07-062 is biased, inconsistent, and reaches conclusions that are arbitrary and capricious. It excluded a major class of flame retardants (halogenated) from consideration as potential alternatives. It excluded a potential alternative flame retardant (BAPP) because it is based on bisphenol A, yet recommends a flame retardant (RDP) that requires a

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[152] SRC (2006), *supra* note 37, at p. 36.
[153] 49 CFR Ch. I (10-1-03 Edition). *Appendix B to §172.101 - List of marine pollutants.*
[154] LaFlamme and Stone, *supra* note 1, at p. 53. Quantity of TPP based on 5% of Ecology's estimated annual usage for RDP.
[155] *Id.* Quantity of resorcinol based on calculation used by Ecology for calculating phosphorous loading from RDP to the Puget Sound.
[156] *Id.*

switch to a bisphenol A-based resin. It concludes Deca-BDE is persistent, yet raises concerns about possible breakdown products.

Attachment 1 - Data as received from the corresponding author of Rice et al. (2007), supra note 65.

Code_Information
Exposure 1=control, Exposure 2=6 mg/kg decaBDE, Exposure 3=20mg/kg decaBDE

SERUM_T4_PERCENT

Litter	Exposure		Sex	T4 Percent Same-sex Control
101	m	1	1	93.595549
102	m	1	1	111.114396
103	f	1	2	97.068689
104	f	1	2	105.987677
104	m	1	1	91.094355
105	f	1	2	106.97203
105	m	1	1	98.835811
106	f	1	2	99.30996
106	m	1	1	109.510156
107	f	1	2	103.905747
107	m	1	1	106.717495
108	m	1	1	107.824776
109	f	1	2	86.789994
110	m	1	1	81.389871
201	f	2	2	99.741815
201	m	2	1	58.059375
202	f	2	2	68.531316
202	m	2	1	69.176891
203	f	2	2	88.689232
203	m	2	1	102.871568
204	f	2	2	88.287094
205	f	2	2	88.936923
205	m	2	1	93.591092
206	m	2	1	104.691471
208	f	2	2	90.511271
208	m	2	1	73.886642
209	f	2	2	82.678915
209	m	2	1	99.580951
210	f	2	2	108.685678
210	m	2	1	121.50615
211	f	2	2	123.616525
211	m	2	1	108.741804
212	f	2	2	73.948491
212	m	2	1	94.251779
213	f	2	2	105.26573
213	m	2	1	86.208864
301	f	3	2	104.816105
302	f	3	2	103.802789
303	f	3	2	122.424255
304	f	3	2	108.56538
304	m	3	1	85.886994
305	f	3	2	66.231797
306	f	3	2	57.871132
306	m	3	1	55.099784
307	f	3	2	75.550964
307	m	3	1	66.152091
308	f	3	2	63.112396
309	f	3	2	104.781199
309	m	3	1	103.443892
310	m	3	1	90.592485
311	f	3	2	82.140458
311	m	3	1	73.426433

LOCOMOTOR_YOUNG_MALE

Litter #	Exposure	Responses, 1st 15min		Responses, 2nd 15min			
Responses, 3rd 15min	Responses, 4th 15min		Responses, 5th 15min		Responses, 6th 15min	Responses, 7th 15min	Responses, 8th 15min
101	1	220	199	138	124	90	187	179	150
102	1	163	40	39	55	12	1	2	8
104	1	119	115	57	76	113	90	89	81
105	1	153	162	101	64	94	33	33	84
106	1	239	244	176	105	149	141	187	140
107	1	152	146	136	130	105	108	74	91
108	1	131	65	58	91	144	146	65	57
109	1	BAD FILE							
110	1	208	186	138	93	82	102	81	98
111	1	235	162	178	195	164	135	94	85
201	2	163	56	75	68	88	85	68	47
202	2	218	186	174	225	170	239	129	144
203	2	88	28	1	4	1	1	0	2
204	2	718	647	587	518	395	507	447	232
205	2	219	182	144	125	110	69	34	28
206	2	234	109	107	128	95	61	15	24
207	2	116	77	90	108	96	105	125	91
208	2	260	159	134	129	110	116	125	120
209	2	273	174	127	75	97	63	82	162
210	2	414	372	491	391	386	384	383	336
211	2	388	441	333	276	279	269	196	310
212	2	756	704	700	797	756	824	733	814
213	2	255	274	329	322	297	271	227	316
301	3	266	181	234	174	225	159	219	154
302	3	225	160	144	165	180	166	121	90
303	3	596	590	384	398	380	158	170	86
304	3	283	197	244	232	227	250	117	154
305	3	691	561	545	564	687	574	452	426
307	3	365	234	262	258	268	289	194	184
308	3	225	131	223	235	116	66	87	85
310	3	330	185	192	218	198	204	136	156
311	3	669	576	567	665	748	390	536	474

WASHINGTON POLICY CENTER
Improving lives through market solutions

Carol Kraege
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December 17, 2008

This is in response to the Department of Ecology's report on alternatives to deca-BDE. Based on the information presented in this and other reports, we have three concerns about their recommendation to certify resorcinol bis(diphenyl phosphate) (RDP) as a suitable replacement for deca-BDE. First, the data in the report has numerous gaps, making an accurate judgment difficult. Second, there is little new data that would cause Ecology to update the assessment of RDP in the 2005 report. Third, the decision violates the precautionary principle which was cited as a justification for banning deca-BDE. That same principle could be used to reject RDP.

The lack of clear science indicates that the choice of RDP is largely subjective and being influenced by political timelines rather than scientific clarity or a legitimate cost-benefit analysis.

Impact Data

In December of 2005, Ecology published their chemical action plan for PBDE[1] which included data on the relative toxicity of deca-BDE and other potential alternatives. In that report, they indicated that the amount of information about RDP was very low, including no information ("NI") for cancer, mutagenicity and "information on routes of potential exposure."[2] Additionally, they listed the amount of toxicity information as low ("L"). There were only two categories where they listed toxicity levels for RDP. For non-cancer effects, the report lists the risk as low (as compared to the risk for deca-BDE of medium) and eco-toxicity where they list the risk as medium (as compared to no information for deca-BDE).

That study indicated that RDP did not meet the standard for a persistent, bioaccumulative toxin (PDT). By way of comparison they list PBDEs, not deca specifically, as a PBT. This, however, is misleading because later Ecology clarified that deca-BDE does not meet the standard but other forms of PBDE might, so they include all of them together because of the possibility of degradation. They wrote, "Ecology and DOH agree that Deca-BDE is not a PBT in terms of meeting the 'P', 'B', and 'T' criteria as specified in Section 320 (2) of the recently adopted PBT Rule (Chapter 173-333 WAC), and as such, based on Deca-BDE's chemical properties, is not a persistent bioaccumulative toxin (PBT)."[3]

At the time, Ecology indicated that there would be additional studies on RDP, and the Chemical Action Plan relied primarily on a study completed for Ecology in 2005 and information from the producer of RDP. This new report by Ecology claims to use new evidence and cites four studies done in 2007. These reports, however, rely on the same reports cited earlier by Ecology or newer versions of studies by the companies that produce RDP.

1 Department of Ecology, "Washington State Polybrominated Diphenyl Ether (PBDE) Chemical Action Plan: Draft Final Plan," December 2005, http://www.ecy.wa.gov/biblio/0507048.html

2 Ibid. p. 71

3 Washington State Department of Ecology and Washington State Department of Health, "Responses to Public Comments on the *Draft* and *Draft Final* Washington State Polybrominated Diphenyl Ether (PBDE) Chemical Action Plan," May 4, 2006, http://www.ecy.wa.gov/pubs/0607014.pdf (Accessed January 15, 2007) p. 9

For instance, the Illinois 2007 study[4] cited by Ecology uses two studies on RDP that date to 2000. There are only two studies published after Ecology's last report, one is a draft for discussion purposes only published in 2006 and the Danish EPA report published in 2007 also cited by Ecology, which does not address RDP.

The Maine study[5] cited by Ecology, is extremely equivocal on the toxicity of RDP. It notes that,

> As with BAPP, there is relatively little information on the fate and toxicity of RDP. Syracuse (2006) considers that it would not be persistent in the environment or bioconcentrate, based on experimental studies (that is, rather than actual performance in the environment). Toxicity to mammals was considered to be moderate based on limited data, but laboratory studies documented high toxicity to aquatic organisms.

They conclude that RDP is less toxic than deca-BDE. This conclusion, however, is based on a lack of information, not positive information that RDP is truly less toxic. This standard appears to offer an innocent until proven guilty approach to alternatives to deca-BDE. This is not a scientific approach and, as we will note later, violates the precautionary principle, the very standard used to ban PBDEs.

This study highlights an irony of the choice of RDP. The Maine study agrees with the Ecology 2005 report, indicating a potentially high level of toxicity to aquatic organisms. Ecology 2005 puts RDP's eco-toxicity level at medium ("M"). The potential threat to Orca was a primary selling point in convincing the legislature to approve the ban on deca-BDE. Ecology argues that RDP is less likely to accumulate in the body which might limit the impact, but the toxicity of RDP should not be ignored, since concern about Orca was cited as a reason to ban deca.

The Danish report does not assess the toxicity of RDP, and instead studies other alternatives.

Finally, the Clean Production Action study provides data that is both uncertain and contradicts other studies. First, the research is based on modeled data, not experimental data. This means the margin of error of the expected impacts is large. Second, the assessment gives RDP only the slightest advantage to RDP over deca-BDE. They classify deca-BDE as "Benchmark 1," which they say indicates "Avoid – Chemical of High Concern." RDP only meets "Benchmark 2," which they translate as "Use but search for safer substitutes." Given the high level of uncertainty and the lack of experimental data, the difference between the two compounds is speculative.

So, of the four studies cited by Ecology, only three cover RDP, only one has experimental, but not environmental, data not available at the time of the first Ecology study (although Ecology 2005 report does cite the Syracuse Research Corporation, it does not specifically cite the 2006 report cited in the Maine study) and all studies indicate that information about RDP is lacking and even indicate that RDP has high toxicity in some circumstances.

This raises the question about why Ecology would be comfortable recommending RDP as an alternative to deca-BDE. It seems unlikely that the deadline for a determination by Ecology to put the ban into effect is not influencing the decision. In every instance, Ecology appears to lean toward "precaution" when it comes to deca-BDE but gives RDP the benefit of the doubt when information is lacking. The bias in this direction is not unexpected, although it is unscientific. Last year we noted that[6]:

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4 Illinois EPA, 2006. DecaBDE Study: A Review of Available Scientific Research; A Report to the General Assembly and the Governor in Response to Public Act 94-100. http://www.epa.state.il.us/reports/decabdestudy/index.html

5 Maine Department of Environmental Protection, "Brominated Flame Retardants: Third annual report to the Maine Legislature," January 2007,http://maine.gov/dep/rwm/publications/legislativereports/pdf/finalrptjan07.pdf

6 Todd Myers, "Banning Flame-Retardant Materials: Weighing Science and Precaution," January 2007, http://www.washingtonpolicy.org/Centers/environment/legislativememo/07_myers_flamematerials.html

> In fact, in the absence of an outright ban, the purpose of the bill can be said to be the creation of a statutory bias against PBDEs. That is one reason that environmental activists refer to the bill not as "examination of alternatives to PBDEs," but as "elimination of all PBDEs."[7]

The goal all along has been to ban PBDEs and the recommendation of RDP despite a lack of clear evidence indicates that political pressure is impacting scientific judgment.

If Ecology is truly comfortable that its determination is scientific, it should not shrink from assuming the liability for subsequent impacts from RDP. This would help businesses and others switch by removing the threat of future efforts to ban the very compound endorsed today by Ecology.

Precautionary Principle

Finally, this decision violates the very principle that was so often cited by supporters of deca-BDE – the precautionary principle. It should be stated up front that we believe the precautionary principle is a nonsensical and unworkable standard that leads consistently to arbitrary decisions. However, Ecology appears to be switching horses mid-stream, applying one standard to deca-BDE and another to RDP.

The Washington Toxics Coalition cites this basic description: "The Precautionary Principle asserts that the burden of proof for potentially harmful actions by industry or government rests on the assurance of safety and that when there are threats of serious damage, scientific uncertainty must be resolved in favor of prevention."[8] Ecology, however, does the opposite. Despite a high level of uncertainty about RDP and the lack of "assurance of safety," Ecology certifies it as a safe alternative. Ecology even admits that additional studies of RDP are necessary. Ecology emphasizes the fact that RDP does not appear to persist, but is more equivocal when it comes to bioaccumulation and toxicity. Thus, it hangs its hat largely on initial indications that RDP doesn't persist. Precaution, as argued by supporters of the principle, however, requires a more rigorous standard.

The clearest indication that they treat the two compounds differently is the admission that deca-BDE is not a PBT but is still listed as a PBT because it might degenerate into PBTs. On the other hand, it is unclear whether RDP will be a PBT, but it is given the benefit of the doubt.

There are only two possible results. Ecology could refuse to certify that RDP is suitable, citing the precautionary principle, or it could indicate that its decision is based on a cost-benefit analysis of RDP against deca-BDE. It appears to be doing the latter. This is the approach we would suggest, but it does not appear to be the approach used to justify banning deca-BDE in the first place.

Conclusion

We were skeptical of the justification for the ban of deca-BDE in the first place, but given the passage of the legislation, Ecology's certification of a suitable alternative must be done scientifically and free of political pressures. This does not appear to be the case in this decision. Given the lack of new information since Ecology last examined this issue, the lack of good information about the impacts of RDP and the fact that certifying RDP violates the very principle used to ban the compound it replaces, the decision appears inappropriate.

It may turn out that RDP is a suitable alternative. At this point, however, that is far from certain and there is simply too little information to judge the relative risks. Certifying RDP at this time indicates that the pressure of the deadline and politics are influencing this decision as much (or more) than science.

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7 Priorities for a Healthy Washington, "Priorities for a Healthy Washington – Eliminating Toxic Flame Retardants," http://www.environmentalpriorities.org/toxicsban (Accessed December 16, 2008)

8 Washington Toxics Coalition, "General Information – Washington Toxics Coalition," http://www.watoxics.org/issues/precautionary-principle (Accessed December 16, 2008)

King County
Solid Waste
Division

King County
Water & Land
Resources
Division

Public Health
Seattle &
King County

Seattle Public
Utilities

Suburban Cities
Association

Participating Cities:

Algona
Auburn
Beaux Arts
Bellevue
Black Diamond
Bothell
Burien
Carnation
Clyde Hill
Covington
Des Moines
Duvall
Enumclaw
Federal Way
Hunts Point
Issaquah
Kenmore
Kent
Kirkland
Lake Forest Park
Maple Valley
Medina
Mercer Island
Newcastle
Normandy Park
North Bend
Pacific
Redmond
Renton
Sammamish
SeaTac
Shoreline
Skykomish
Snoqualmie
Tukwila
Woodinville
Yarrow Point

Local Hazardous Waste Management Program in King County, Washington

December 17, 2008

Carol Kraege
Department of Ecology
Reducing Toxic Threats Section
P.O. Box 47600
Olympia, WA 98504-7600

Dear Ms. Kraege:

I am writing on behalf of the Local Hazardous Waste Management Program in King County (Program) to support findings of the Washington State Department of Ecology's alternatives to Deca-BDE in televisions, computers and furniture.

Our Program is a multi-jurisdictional partnership serving over 1.8 million residents in the City of Seattle, the unincorporated areas of King County, and thirty-seven other cities in King County. Our Program Partners include Public Health – Seattle & King County, Seattle Public Utilities, the Suburban Cities, and King County Department of Natural Resources and Park's Solid Waste and Water and Land Resources Divisions.

The Program's Strategic Plan includes goals to reduce hazardous materials in products. We believe Ecology's finding on Deca-BDE is an important step forward in removing hazardous materials from consumer products in Washington State. However, we do have a few comments to offer about your findings:

- Ecology recommends RDP over TPP because TPP reportedly exhibits greater aquatic toxicity. However, it is not clear whether RDP is intrinsically less toxic or its favored status reflects a lack of aquatic toxicity data.

- The principal concern expressed about BAPP is that it may degrade to Bisphenol A. However, without any information about the extent of this degradation and the consequent potential for human and environmental exposure, it is not clear whether this degradation represents a hazard.

- There appears to be a data gap associated with characterizing the toxicity and environmental fate of these alternatives.

I would be happy to discuss these comments with you in greater detail. If you have any questions or need more information, please feel free to contact me at jay.watson@kingcounty.gov or at (206) 240-5977.

Sincerely;

Jay L. Watson, PhD
Administrator

December 17, 2008

Carol Kraege
Department of Ecology
Reducing Toxics Threats Section
PO Box 47600
Olympia, WA 98504-7600

Dear Carol:

Thank you for the opportunity to comment on the draft "Alternatives to Deca-BDE in Televisions, Computers, and Furniture" report. The report is scientifically strong, well documented, and thorough. We appreciate all the hard work of agency staff that contributed to this report, which serves as an excellent model for how to evaluate alternatives to chemicals of high concern. The report will also be extremely valuable for other states that are evaluating alternatives to deca.

We, the undersigned groups, fully support the agency's findings that safer, technically feasible alternatives to deca, that meet applicable fire safety standards, are available for televisions, computers and residential upholstered furniture. These findings will trigger the ban on deca in these applications on January 1, 2011.

Since adoption of Washington's law in 2007, there have been numerous developments in the science and in policy that further supports Washington's state ban on deca. For example:

- A November 2008 study in the Journal of Neurotoxicity (N. Johansson, et al.) showed that deca (PBDE 209) can be as potent as the lower brominated PBDEs (penta/octa) in causing developmental neurotoxic defects. This confirmed a 2003 study on deca toxicity.

- Following Washington's lead, Maine adopted a ban on deca that goes into effect in 2010.

- Europe's ban on deca in electronics, under the Restriction on Hazardous Substances (RoHS) directive, took effect in June 2008.

- An Environmental Working Group study found that young children have an average of three times the levels of PBDEs in their bodies as their mothers.

Due to the bans on deca, and increasing concerns over the environmental and health impacts of all halogenated flame retardants, companies are moving to safer alternatives and clearly demonstrating their availability n the marketplace. Electronics manufactures, including Apple, Dell, Samsung, Phillips and others have chosen non-halogenated flame-retardants to meet fire safety standards. In addition, mattress manufactures are already using non-chemical alternatives to meet new federal fire safety requirements and similar approaches can be used for residential upholstered furniture to meet upcoming federal fire safety standards.
The report adequately reflects this marketplace reality. For residential upholstered furniture it

concludes that the best approach for meeting fire safety standards is to use non-chemical alternative design changes. This conclusion is based primarily on the fact that the Consumer Product Safety Commission proposed standard does not require the addition of chemical flame-retardants to meet the standard. The standard can be met with the use of certain cover materials or internal barrier layers.

The report also concludes that a safer alternative to deca in electronic enclosures (televisions and computers) is RDP, a phosphorous-based alternative already in use by major manufactures. This alternative meets the same fire safety standard (Underwriters Laboratory 94 V-O rating) as deca. The state of Maine came to the same conclusion on RDP before passing its law in 2007.

Finally, this report highlights the need for the state to look at flame-retardants as a class and address other problematic flame-retardants in the near future. While some companies have chosen safer, non-halogenated alternatives, others have chosen to use compounds that could be just as problematic as deca. For example, some companies have chosen to use other brominated chemicals that are similar to deca. The state should be able to regulate other toxic flame-retardants to ensure only the safest ones are used in consumer products.

We appreciate the opportunity to provide comments on this important report. Again, we fully support the recommendations and the state moving forward in enacting its ban on deca in electronic enclosures (televisions, computers) and residential upholstered furniture.

Please contact Laurie Valeriano at 206-200-2824 if you have further questions. Thank you.

Sincerely,

Laurie Valeriano
Policy Director
Washington Toxics Coalition

Karen Bowman, MN, RN, COHN-S
Washington State Nurses Association

Cherie Eichholz
Executive Director
Washington Physicians for Social Responsibility

Blair Anundson
Consumer Advocate
WashPIRG

Heather Trim
People for Puget Sound

December 17, 2008

Carol Kraege
Department of Ecology
Reducing Toxic Threats Section
P.O. Box 47600
Olympia, WA 98504-7600
e-mail: ckra461@ecy.wa.gov

Dear Ms. Kraege:

I am writing to comment on the proposed report on alternatives to Deca for computers, televisions and furniture per RCW 70.76.

WRA represents several members that offer for sale computers, televisions, and furniture. We are concerned that the report identifies RDP as a safe and effective alternative to Deca-BDE. Manufacturers of these flame retardant products have told us that they are concerned with the increased costs and availability of the consumer goods that would use them. There is insufficient data that shows the alternative would be safer and easier to use.

My members do not want to have the supply chain of these products interrupted unnecessarily or have additional operating costs and availability issues. I would encourage you to postpone the adoption of the alternatives report until a more thorough review can be conducted to ensure both safety and ease of compliance. Perhaps meeting with and verifying results with the manufacturers would be a prudent step.

I appreciate your consideration. Please let me know if I may be of any assistance.

Sincerely:

Mark Johnson

Vice President of Government Relations
Washington Retail Association
PO Box 2227
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Cell: 360-704-0048

Fx: 360.943.1032
mark.johnson@retailassociation.org

Carol Kraege

Department of Ecology
Reducing Toxic Threats Section
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ckra461@ecy.wa.gov

RE: Public Comment on the Department of Ecology and Department of Health report, "Alternatives to Deca-BDE in Televisions, Computers, and Furniture".

Submitted via email.

Thank you for the opportunity to provide comment regarding this issue. I have concerns with the economic consequences that businesses in Washington State will face from the conclusion and ultimately the mandate from this report.

As a past Washington State member of the Small Business Association's National Advisory Board, I am troubled by government decisions that will hinder business success. It is my understanding that by requiring manufacturers to switch from Deca-BDE to RDP, Washington State will be forcing significant higher operating costs on business.

While there are certainly times and compelling reasons for government to do so, I question whether it is warranted in this case. Washington businesses are already facing an incredibly difficult economic situation. Placing additional regulation, higher costs, and creating a situation where Washington State is the only state with such a regulation could be the final nail for many businesses.

Jeff Turner
701 5th Avenue, Suite 4200
Seattle, WA 98104

Reducing Toxic Threats Section
300 Desmond Way SE
Lacey, WA 98503

Please consider the following as public comment regarding the joint Department of Ecology and Department of Health report, "Alternatives to Deca-BDE in Televisions, Computers, and Furniture".

As an individual who has worked for and with large retailers in the downtown Seattle market, I am concerned about the potential affect to Seattle and Washington State retailers and businesses. It is my understanding that mandating manufacturers to switch from Deca-BDE to RDP will place an undue burden on manufacturers wishing to distribute and sell their products in Washington – a burden that they will not face in other states.

Such a situation could limit items that Washington retailers could market and sell. In light of the current economic situation, anything that puts our retailers and businesses at a disadvantage needs to be thoroughly studied and have compelling justification.

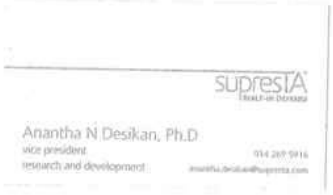
I believe further consideration should be given to this issue and the economic consequences of any mandates or changes.

Thank you,

Randy Hurlow
1119 1st Avenue, Suite 205
Seattle, WA 98101

Flame Retardants for Fire Safety

Department of Ecology, State of Washington
December 15th, 2008



Responsible Care®

Agenda

- Need for Fire Safety
- Fire Retardants – the Science
- Fire Retardants and substitution
- European Union Status

Responsible Care®

Why Use Flame Retardants?

- **Flame retardants improve fire safety for the public**
  - Prevent or slow spread of fire
  - Increase escape time up to 15x
- **Flame retardants increase response time, reduce fire intensity for firefighters**

US Fire Facts: per year

- Deaths – 3,855 civilians, 117 firefighters
- Injuries – 17,785
- Property Damage - $10 billion

Responsible Care®

Flame Retardant Plastics That Could Contain Deca-BDE

Unsaturated Polyesters — Phenolic Resin — Elastomers — Polyethylene (PE)

Latex backcoatings (Fabrics)

Polybutylene terephthalate (PBT)

Epoxy Resin

High-Impact Polystyrene (HIPS)

Rubber

Nylon (PA)

Polypropylene (PP)

End Uses of these Flame Retardant Materials

- Wire & Cable
- Sealants & Caulks
- Electronic Enclosures
- Textiles
- Electrical Connectors
- Conduit
- Ductwork (flexible)
- Motor Housings
- Switches
- Light Fixture Housings
- Electric Distribution Boxes
- Relays
- Adhesives

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Fire Retardants – PLASTICS

- RDP
  - Oligomeric phosphate ester based flame retardant
  - Different flame retarding mechanism - char vs gas phase
  - Different physical state - viscous liquid vs solid powder

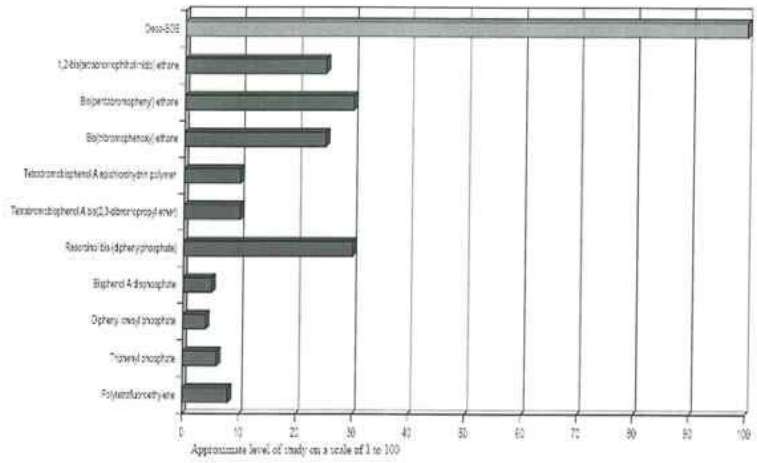
- Compared to DECA
  - PC/ABS and PPO/HIPS compared to HIPS and ABS for DECA
  - Requires reformulation, retooling, reengineering and recertification
  - RDP cannot be used to flame retard HIPS and ABS while maintaining physical properties of these resins
  - Requires liquid handling vs solid handling (more energy demand)
  - Challenges by using polymer systems like PPO/HIPS
  - Changes Impact smaller manufacturers

- One to One replcaement of DECA with RDP is not straight forward

Fire Retardants - TEXTILES

- Alternatives
  - Vapor phase mechanism is critical in this application
  - Hydrolytic stability
  - Typically higher loadings are required
- Compared to DECA
  - Redesign has a big impact on manufacturers
    - Higher cost due to materials and labor costs
    - Not similar to mattress application
  - DECA continues to be used in Europe to meet regulations
  - CPSC findings on DECA and alternates were favorable for this application
- Replacement of DECA with alternates or redesign is not straight forward
- Recommendation will be step backwards in fire safety

Alternative Flame Retardants: A Comparison of Scientific Analyses



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Fire Retardants – Comparing the Science

- REACH
  - DECA has gone through a formal Risk Assessment with a favorable outcome
  - RDP will be reviewed under the REACH protocol
- State of Washington report identifies data gaps for alternatives
- Uncertainty over environmental and human health exposure pathways in finished articles for alternatives

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Summary

- Chemical Comparisons are difficult:
- DECA has a favorable European Union Risk Assessment and no restrictions of use
- DECA is REACH compliant
- DECA currently is restricted from use only in electronic and electrical applications in the European Union under RoHS
  - This was based on a procedural issue not on risk assessment
- DECA and RDP are flame retardants with unique and different properties which offer manufacturers to use different polymer systems to achieve fire safety
- Options for compounders and molders will be limited if RDP has to be used in place of DECA
  - Resins have to be replaced
- Other applications have no viable alternative

Federation of Burn Foundations

To: Washington State Department of Ecology
Olympia, WA 98504-7600

RE: "Alternatives of Deca-BDE in Televisions, Computers and Residential Upholstered Furniture",

Date: December 6, 2008

On behalf of the Board of Directors of the Federation of Burn Foundations, I am writing to express our strong support for the findings of the above report, as required by RCW70-76 and jointly released by the Washington State Departments of Ecology and Health on November 20, 2008.

We are pleased that your departments have after careful study reached the conclusion that sufficient alternative approaches to fire safety are available to enable the phasing out of deca-BDE as a flame retardant, as provisionally approved in state legislation two years ago. We thus endorse your recognition of the flame retarding qualities of resorcinol bis diphenyl phosphate, along with your references to the value of alternative materials and product design, as described in the current Notice of Proposed Rulemaking (NPR) for Upholstered Furniture Flammability of the U.S. Consumer Product Safety Commission (CPSC).

Our Federation members include 60 local, regional and national organizations in the United States, Canada and overseas that are committed to programs that support burn centers, burn prevention, and burn injury survivors. Their Boards of Directors typically include burn care professionals, firefighters, and burn injury survivors, who are acutely aware of the causes of death from fire and burns and the suffering of those who survive their injuries.

With these concerns in mind, our Federation Board nonetheless approved on March 25, 2008 a policy statement expressing grave concern about the health and environmental impact of brominated flame retardant chemicals (copy attached). We thus have endorsed the current NPR of the CPSC on upholstered furniture flammability, as well as your own report on the issue. We hope your report will have a positive impact as other states consider following your lead in reducing the threat posed by these chemicals, which is thoroughly documented in the scientific literature.

Sincerely,

Peter A. Brigham
Founding and Emeritus Board Member
Federation of Burn Foundations

Federation of Burn Foundations

Board Policy Statement on Flame Retardant Chemicals

The Board of the Federation of Burn Foundations (FBF) wishes to express its deep concern over the increasing presence of brominated and chlorinated chemicals (BFRs and CFRs) in the environment and in human tissue, resulting from their common use as flame retardants. The hazards represented by these chemicals have been repeatedly demonstrated in animal laboratory studies and their global presence has increased substantially since these chemicals first began to be used extensively in consumer products in the 1970s.

Efforts to strengthen product flammability regulations at the state, national and international level, initiated and sponsored by the flame retardant chemical industry, have accelerated in recent years. These efforts have gone forward in the absence of evidence that stronger regulations would significantly reduce fire death and injury, or could be implemented without adding unacceptable levels of potentially toxic flame retardant chemicals into the environment. At the same time, efforts have gained momentum mainly at the state level, to reduce or eliminate the use of the most common flame retardant chemicals.

Recognizing the need for continuing protection of the public from undue risk of fire, the Federation of Burn Foundations endorses the strengthening of other approaches to fire safety that do not depend on the use of brominated and chlorinated chemicals as flame retardants, while supporting efforts to reduce or eliminate the use of such chemicals.

-March 20, 2008