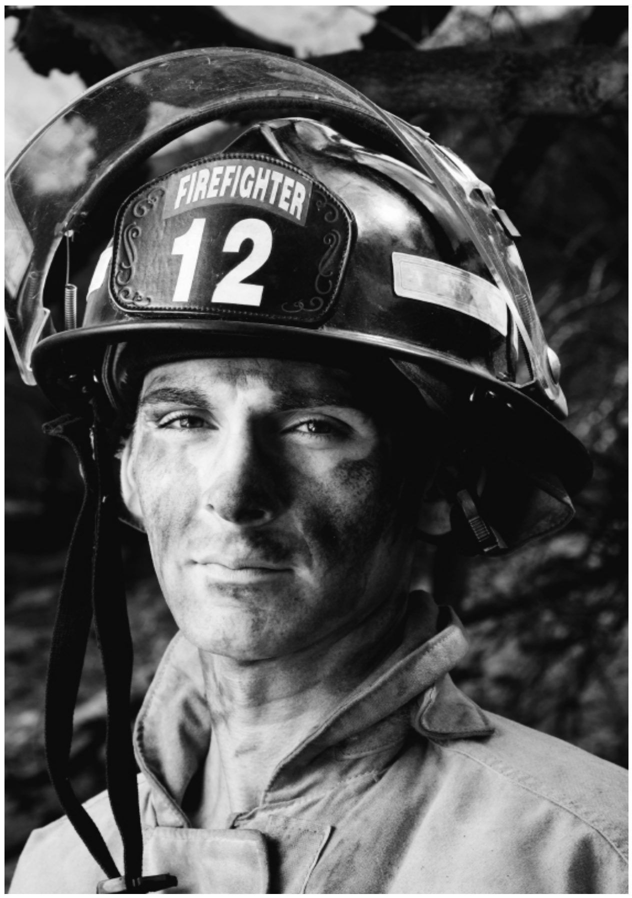
Toxic Flame Retardants:

The Impact of Decabromodiphenyl ether on Health and the Environment



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INTRODUCTION

Chemical flame retardants are added to a variety of products, such as televisions, computers, and fabrics to stop fires from occurring or to slow the rate at which a fire spreads. Three different types of flame retardants are commonly used today: brominated, phosphorus-based and inorganic. While the uses of all three are prevalent, brominated flame retardants are the most widely used internationally.[1]

What are PBDEs?

Polybrominated diphenyl ethers (PBDEs) are toxic flame retardants used in textiles, electrical equipment, and building and transportation materials.

PBDEs are reproductive and developmental toxins that are widely found in the environment and build up in the human body.

There are three commercial forms of PBDEs known as Penta, Octa, and Deca.

Brominated flame retardants (BFRs) were first used in the 1960's and grew in popularity due to their low cost and high efficiency. As states enacted stricter fire safety laws, this combination of cheap and effective served to increase the use of BFRs. While these chemical additives have been credited with saving lives and property, mounting scientific evidence suggests that they are also harming the very individuals they were designed to protect.

Serious environmental health concerns have been raised regarding polybrominated diphenyl ethers (PBDEs), the main class of BFRs. The three main commercial mixtures of PBDEs are pentabromodiphenyl ether (Penta), octabromodiphenyl ether (Octa) and decabromodiphenyl ether (Deca). Penta was primarily added to foam materials used in household furniture and mattresses. Octa was added to the plastics found in office equipment and small domestic appliances. And Deca is most often added to high-impact polystyrene (HIPs) that is used in TV casings, computers and other electronics.

Penta and Octa raised concerns after studies found that the chemicals bioaccumulate in our bodies and persist in the environment. Penta and Octa are endocrine disruptors and can cause neurobehavioral effects in laboratory animals.

Due to mounting health concerns, the sole U.S. manufacturer of Penta and Octa voluntarily ceased production of the chemicals in 2004.

In 2003, California became the U.S. first state to pass legislation banning Penta and Octa. Soon after, Maine, Hawaii and New York followed suit. Due to mounting pressure, Great Lakes Chemical (now the Chemtura Corporation) voluntarily ceased production of Penta and Octa in 2004. Great Lakes Chemical was the sole U.S. manufacturer of Penta and Octa.

Of the three commercial mixtures, Deca is the only one that remains on the market. However, Deca's continued use is not because scientific testing has proven the chemical to be safer. Deca was previously excluded from past PBDE studies because the molecule was believed to be too large to bioaccumulate in organisms. However, recent studies have shown this assumption to be false.

Biomonitoring studies have detected Deca in human breast milk, blood, blood serum, tissues, and semen. Deca has also been detected in wildlife such as fish, birds, dolphins, and polar bears. Deca has even been found in meat and dairy products, the ambient air, wastewater, and water bodies like the Great Lakes.

The commercial use of Deca is even more worrisome because of evidence that Deca breaks down, or debrominates, into lower-brominated PBDEs including compounds present in Octa and Penta.

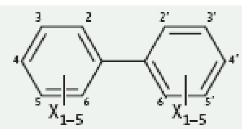
Due to the growing body of data on Deca's persistence and toxicity, Washington and Maine became the first U.S. states to enact bans on the chemical's use. As of March 2008, eleven states had introduced similar legislation.

Eleven states have banned Penta and Octa:

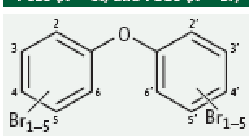
- **California**
- **Hawaii**
- **Illinois**
- **Maine**
- **Maryland**
- **Michigan**
- **Minnesota**
- **New York**
- **Oregon**
- **Rhode Island**
- **Washington**

CHEMICAL DESCRIPTION OF PBDES

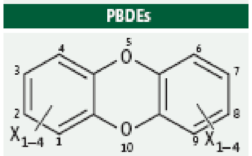
Polybrominated diphenyl ethers (PBDEs) are members of a broader class of brominated flame retardants (BFRs). They are added to a wide range of consumer products, including computers and other electronics, furniture, and carpeting to prevent or slow the spread of fire. PBDEs have been continuously produced and used as flame-retardant additives since the 1970s.



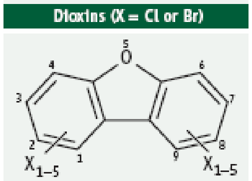
PCBs (X = Cl) and PBBs (X = Br)



PBDEs



Dioxins (X = Cl or Br)



Furans (X = Cl or Br)

There are 209 different molecules in the PBDE class, each named according to the number of attached bromine atoms and their geometry. The different molecules are called congeners, and each one is assigned a number: the bigger the number, the larger the molecule. PBDEs closely resemble PCBs, dioxins, and furans in their chemical structure, and they are produced commercially as mixtures, much as PCBs were. PCBs were banned in the 1970s due to their high toxicity, persistence in the environment, and evidence that they can cause developmental problems in children.

Three different mixtures of PBDEs are commercially available: Penta, Octa, and Deca. Each product contains a mixture of different molecules with different numbers of bromines attached. The Penta-BDE product contains a mixture of molecules composed of congeners with three to six bromine atoms; the Octa mixture is composed of congeners with six to nine bromine atoms; while the Deca product is almost entirely composed of congeners that contain nine to ten bromine atoms, or what is most often identified as the BDE-209 congener.[2]

PBDEs closely resemble PCBs, Dioxins, and furans in their chemical structure.

CURRENT USES OF DECA

Approximately 80% of Deca used in the United States is in electronics and electrical equipment, with the vast majority used in the plastic casings of televisions.[3] Deca is primarily added to high impact polystyrene (HIPS), the hard plastic used to make TV enclosures. The use of Deca in other electronic enclosures such as the casings of computer monitors is very rare.

The second largest use of Deca is in textiles, consuming 10-20% of global production. According to The Lowell Center for Sustainable Production, the primary textile uses of Deca are in the commercial upholstered furniture, drapery, mattress, and transportation industries.[4] However, Deca is not currently applied to residential upholstered furniture or clothing.

In addition, the mattress industry is shifting away from the use of Deca. The International Sleep Products Association (ISPA) - a trade group representing mattress manufacturers – has indicated that all of its members are currently using flame resistant technologies that reduce the need for chemical flame retardants. Manufacturers have also avoided the use of Deca to meet a national flammability standard that took effect in July 2007.[5]

The vast majority of Deca is used in the plastic casings of televisions.

PBDES IN THE ENVIRONMENT, WILDLIFE, HUMANS, AND PETS

PBDEs are persistent and bioaccumulative toxins, meaning they persist in the environment for long periods of time and accumulate in the tissues of living organisms. PBDEs also biomagnify, meaning that they build up in our bodies through the food chain. The widespread use of PBDEs and their ability to detach from products has resulted in their contamination of the environment and humans across the globe with levels increasing at exponential rates.

Environmental Exposure

PBDEs are widespread environmental contaminants. They have been found in the air, sediments and sewage, and wildlife. PBDEs have even been found in species located in remote corners of the world.

<u>Outdoor Air</u>

PBDEs are found in the outdoor air of urban and rural areas. However, current evidence suggests that PBDE concentrations in the air may be higher in urban areas. The two manufacturing plants of Albemarle and Great Lakes Chemical are thought to be a significant source of PBDE pollution in the U.S. and Canada.[6]

Studies also indicate that levels of Deca are on the rise. The levels of PBDEs in the Chicago air were measured during 1997-1999 by one study and again in 2002-2003 by another.[7] In 1997-1999, Deca contributed only trace amounts to the total PBDE air samples.[8] However, in 2002 Deca was an abundant part of the PBDE concentrations.[9]

<u>Sediments and Sewage</u>

The presence of PBDEs in sediments and sewage are of great concern. PBDEs have been found in the soil of waterways across the world, and levels of Deca in sediment are increasing.

Several studies have measured PBDEs in the soil of the Great Lakes and have found high concentrations of Deca. It is estimated that 92 tonnes of Deca is in the soil of the lakes, while other PBDEs makeup approximately 5.2 tonnes.[10] In Lake Superior alone, the total amount of

Deca has been found in sewage sludge. More than half of the sludge produced by wastewater treatment plants in the U.S. is applied to the land, often as fertilizer for farmland.

PBDEs in the soil is approximately 2-6 tonnes with Deca comprising 83-94% of the total PBDE concentration.[11]

Deca and other PBDEs have also been discovered in sewage sludge.[12] This is critically important as more than "half of the sewage sludge generated by wastewater treatment plants in the U.S. is applied to land," often as a fertilizer for farmland.[13] While sewage sludge is treated for pathogens and other toxins, it is not screened for PBDEs.

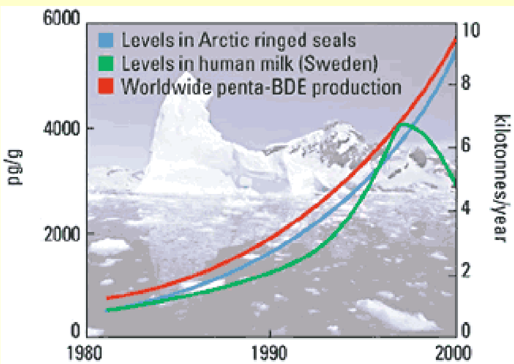
Wildlife

PBDEs have contaminated wildlife from across the globe. These toxic chemicals have been found in fish, birds, dolphins, foxes, seals, and other species. PBDEs have even been found in animals in the arctic.

Endangering the Arctic

The Arctic has become a sink for persistent organic pollutants (POPs).

PBDE levels in ringed seals in arctic Canada are doubling every 4 to 5 years and parallels increases in worldwide production.



Source: Ikonomou, MG, S Rayne and RF Addison. 2002. Exponential Increases of the Brominated Flame Retardants, Polybrominated Diphenyl Ethers, in the Canadian Arctic from 1981 to 2000. Environmental Science and Technology 36:1886 -1892.

PBDEs have been measured in many different species of fish in various water bodies across the U.S. In one study, fish were collected from 32 different water bodies in Washington State. PBDEs were found in 120 fish fillet samples and 23 whole fish samples. Deca was detected in 6% of the samples.[14] PBDE concentrations have also been measured in lake trout, lake herring and white sucker in Lake Superior.

PBDEs have also polluted other marine life. In one study conducted off the coast of Florida, eleven animals were tested. The study's results not only indicated the presence of PBDEs, but provided further evidence that PBDEs biomagnify. According to the study, sharks and dolphins had the highest levels of PBDEs with levels in sharks being 1-2 times higher than levels in fish lower on the food chain. Sharks also had the highest concentrations of Deca, with Deca making up 60% of their total PBDE concentrations.[15]

PBDEs have even been found in species living in the Arctic, indicating the ability of the chemicals to travel long distances, impacting remote corners of the world. Arctic foxes, polar bears, ringed seals, and gulls have all been found to have levels of PBDEs in their bodies.[16]

PBDEs in Humans

PBDEs have been found in the bodies of people across the world and levels of the toxins are increasing at an exponential rate. Total PBDE levels in breast milk, blood and tissues have increased by a factor of 100 during the past 30 years, doubling roughly every five years.[17]

Earlier body burden studies focused solely on lower-brominated congeners because the Deca molecule was believed to be too large to bioaccumulate in humans. However, recent analyses have proven this assumption false and have identified Deca in the bodies of children and adults. Studies also indicate that Americans are the most polluted people in the world and American children have higher concentrations of PBDEs in their bodies than adults.

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PBDE levels in Americans are the highest in the world. Concentrations of PBDEs in Americans are 10 to 20 times higher than those found in Canadians and Europeans.[18] In addition, levels of PBDEs in U.S. women's breast milk are 10 to 100 times higher than levels in European women.[19,20]

One study measured the blood of 34 Americans from 7 states, including New York, Massachusetts and Connecticut. The age range of the participants spanned from 12 to 66 years. Deca, along with Penta and Octa, was detected in all 34 people.[21]

PBDEs in Children

Children have been found to have higher levels of PBDEs in their bodies than adults. In the first nationwide investigation of flame retardants in parents and their children, the Environmental Working Group found that toddlers and preschoolers typically had 3 times more PBDEs in their blood than their mothers. The study examined 20 families and found that 86% of the time children had higher levels of PBDEs than their parents.[22]

Another study measured the blood of a family of four in California. The two children in the family, one 5-year old and one 18 month old, had PBDE levels in their blood that were 2 to 5 times higher than the levels of their parents. The levels of PBDEs, including Deca, in the toddler's blood were fairly close to levels where reproductive and neurological effects have been observed in laboratory animals. The Deca levels in the toddler's blood were also comparable to occupational exposures found in workers manufacturing Deca-treated rubber.[23]

Exposure in the Womb

Children are even exposed to PBDEs before they are born. Fetuses are incredibly vulnerable to toxic exposures as cells are rapidly dividing and the systems of the body are in their earliest stages of development. For example, a fetus has an immature blood brain barrier that may allow greater chemical exposure than that of an adult, in addition to the diminished ability of a fetus to excrete and detoxify many chemicals.[24]

Quick Facts:

- **Total PBDE levels in breast milk, blood and tissues have increased by a factor of 100 during the past 30 years, doubling about every five years.**
- **Levels of PBDEs in U.S. women's breast milk are 10–100 times higher than levels in European women.**
- **Deca and other PBDEs are able to penetrate the placenta barrier and enter the body of a fetus.**

Deca and other PBDEs are able to penetrate the placenta barrier and enter the body of a fetus. In a study examining the cord blood of ten newborns throughout the country, PBDEs were present in all ten babies. Deca was found in three of the newborns, while Penta was measured in nine of the babies and Octa was found in all ten.[25]

Children are even exposed to PBDEs before they are born.

Dangers to Household Pets

PBDE exposures in the home are not just dangerous to people, but to their pets as well. Household cats spend the majority of their time in the home and are exposed to furniture and electronics. Cats collect dust on their fur and large amounts are ingested primarily through their grooming practices.[26]

In the 1970's, hyperthyroidism (the increase in production of thyroid hormones by the thyroid gland) was relatively rare in cats. Feline hyperthyroidism has now become an epidemic. This surge of thyroid disease in cats correlates to the surge in demand for PBDEs during the same time period. California, with its stringent fire standards, saw a disproportionate increase in the number of cats with feline hyperthyroidism at veterinary teaching hospitals during the 1980's.[27]

Cats are the only mammals, besides humans, that have a high incidence of hyperthyroidism. Researchers have attributed cats' exposure to PBDEs to food and indoor air. Canned cat food contains high levels of Penta, while dry cat food contains high levels of Deca. Cats also consume the same amount of dust as children. [28] All of these factors have led researchers to believe that cats may serve as sentinels of PBDE exposure for humans.

Cats are not the only pets being exposed to high levels of PBDEs. Dogs are exposed to PBDEs while lying on upholstered furniture, beds and floors. Dogs also ingest dust from typical activities such as biting on chew toys, licking, and eating table scraps off the ground. A study conducted by the Environmental Working Group measured PBDEs in 20 dogs and found Deca levels that were on average 16.8 times higher than levels measured in adult humans. The study also detected 19 different PBDEs in the dogs' blood, with Penta and Deca as the most prevalent.[29]

The surge of thyroid disease in cats correlates to the surge in demand for PBDEs during the same time period.

Special attention should be paid to the affects that PBDEs have on pets. Just like their owners, they spend the majority of their time in the home. Cats and dogs have shorter life spans than humans and shorter latency periods for diseases like cancer. The high exposures in these animals, as well as the health problems in cats, should serve as a warning to the dangers of PBDEs.

PBDEs have been detected in breast milk, animal products, fruits, and vegetables.

ROUTES OF EXPOSURE

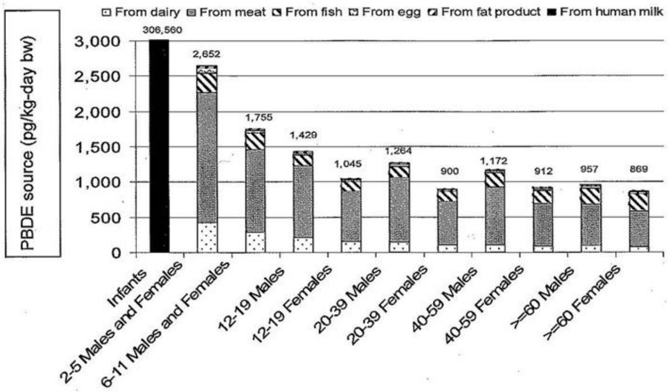
The primary routes of exposure to PBDEs are through diet and the inhalation of household dust.[30]

PBDES in the Food Supply

PBDEs have made their way into in the U.S. food supply. The toxins have been detected in animal products including breast milk as well as fruits and vegetables. However, concentrations of PBDEs in fruits and vegetables appear to be significantly lower than those found in animal products.[31]

One study surveyed 62 samples of meat, fish, and dairy products bought at grocery stores in the United States. It found that PBDE levels were highest in fish, followed by meat and dairy products.[32] However, because meat makes up a large portion of the typical American diet it is believed to be the greatest contributor to a person's dietary PBDE exposure. According to the same study, catfish, salmon fillet, ground turkey, and cream cheese contained high levels of Deca.

PBDE Dietary Intake of U.S. Population by Age and Food Group (Schecter et al., 2006) (Taken from: Kodavanti, 2007)



Research also indicates that infants and young children are the most vulnerable to dietary exposures. Nursing infants consume the greatest levels of PBDEs followed by young children and then adults. According to an assessment by Health Canada, breast-fed infants (aged 0-6 months) have the highest exposures with 92% coming from breast milk.[33]

Nursing infants consume the greatest levels of PBDEs followed by young children and then adults.

Contaminated Household Dust

Household dust is another major source of exposure to PBDEs. According to a recent study, household dust accounted for 82% of total PBDE exposures.[34] Deca has been shown to make up anywhere between 41 to 50% of the PBDE concentrations of household dust.[35,36]

Children are particularly vulnerable to dust. Their frequent hand-to-mouth contact and their ability to breathe more air per pound of body weight than adults, heightens their exposure to contaminants. Children 0-4 year's of age touch their mouths approximately 16-18 times per hour, compared to children 6-13 who only touch their mouths 2 times per hour.[37] Ingesting dust contaminated with PBDEs can lead to as much as a 100-fold higher PBDE exposure level in toddlers than adults.[38] Studies indicate that 80 to 90% of a toddler's daily average intake of PBDEs is the result of dust exposure.[39,40]

Correlations have been found between PBDE levels in dust and blood, as well as dust and breast milk.[41] Breast milk is an infant's highest exposure to the lower-brominated PBDEs, but dust may be an infant's highest exposure to Deca.[42]

Adults also face exposure risks to contaminated dust. "Personal" exposure to Deca via dust has been found to be 4 times higher than the levels measured in passive air samples collected in homes. As people move about their homes, they stir up dust, creating their own dust clouds. As a result, greater amounts of Deca are inhaled and absorbed into the body. The inhalation of Deca may account for at least 22% of an adult's total Deca exposure.[43]

TOXICITY OF PBDES

There is a growing body of evidence that PBDEs have toxic effects. Among other things, PBDEs have been found to influence development, disrupt the endocrine system, and damage the liver.

While other PBDEs such as Penta and Octa are believed to be more toxic than Deca, Deca has had troubling impacts on the health of laboratory animals. Deca has been found to disrupt the endocrine system, impair development, damage the liver, and is considered a possible human carcinogen by the U.S. Environmental Protection Agency.

In addition, Deca can breakdown, or debrominate, into more toxic PBDE congeners such as Octa and Penta. This makes the toxicity of Octa, Penta, and other lower-brominated congeners relevant to the health implications of Deca.

Health Impacts of PBDEs

- **The U.S. Environmental Protection Agency considers Deca a possible human carcinogen.**
- **Exposure to Deca in mice and rats during brain development "can give rise to irreversible changes in adult brain function."**
- **PBDEs have been linked to delayed onset of puberty and reproductive development.**
- **Deca has the ability to cause the same effects on developing brains of mice as Penta, which has already been banned in eleven states and Europe.**
- **Deca can break down into components present in Octa and Penta.**
- **An estimated 5 percent of American women have levels of PBDEs in their bodies greater than levels that have been shown to cause reproductive problems in laboratory animals.**

Source: See Appendix A

Endocrine Disruption

Thyroid Issues

Thyroid hormones are essential in maintaining critical functions of the body such as metabolism, heart rate, blood pressure and body temperature. These hormones are also important for healthy brain development in fetuses and young children. Interference in development during this critical period can lead to learning disabilities and other detrimental effects.

Studies have found that PBDEs can disrupt the thyroid. Exposure to the commercial mixtures of Penta and Octa for only a few days significantly decreased thyroid hormones in rats.[44] Mice exposed to Deca shortly after birth also had decreased levels of thyroid hormones.[45]

Reproductive Issues

Another consequence of PBDE exposure is irreparable damage to reproductive organs. Exposure to lower-brominated PBDEs has produced developmental and functional damage to reproductive organs as well as a delayed onset of puberty in laboratory animals.[46,47] And exposure to both Penta and Deca has been linked to decreased sperm counts in male mice.[48,49]

Neurobehavioral Effects

The neurobehavioral system may be the most sensitive in the body to PBDE exposures and is of great concern due to the potential impacts on breast-feeding infants. Infant mice exposed to PBDEs during a critical point in their development have experienced memory and learning deficits and displayed hyperactivity.[50,51]

Exposure to Deca during development has been linked with changes in spontaneous activity even after reaching adulthood. These effects seem to worsen with age.[52] Studies also indicate that Deca "can be as potent as the lower brominated PBDEs in causing developmental neurotoxic defects."[53] In fact, Deca has the ability to cause the same effects on the developing brains of mice as Penta,[54] which has already been banned in ten states and Europe.

The U.S. EPA considers Deca to be a possible human carcinogen.

Liver Damage

Exposure to PBDEs can also result in disorders of the liver. Penta, Octa, and Deca have been linked to the enlargement of the liver in rats.[55] In addition, exposure to Deca has been associated with thrombosis of the liver, liver degeneration, and centrilobular hypertrophy of liver.[56]

The Impact of PBDEs on Fire Fighters

Fire Fighters from across the country have come out in opposition to PBDEs. This includes the International Association of Fire Fighters (IAFF) which "represents more than 280,000 full-time professional fire fighters and paramedics who protect 85% of the nation's population."

According to the IAFF, "many studies involving fire fighters exposed to these and other toxic gases during active fire fighting, overhaul, and long term exposure from these chemicals penetrating protective gear, have found that fire fighters have a much greater risk of contracting cancer, heart and lung disease, and other debilitating diseases."

"While we support the concept of flame retardant chemicals, there are alternatives that do not contain bromine or chlorine and are much safer for fire fighters than PBDEs."

Source: International Association of Fire Fighters, Letter to Washington State Council of Fire Fighters, January 26, 2007.

Cancer

PBDEs have been associated with cancer. Exposure to PBDEs in the womb has been linked with an increased risk of testicular cancer in men.[57] In addition, Deca is considered to be a possible human carcinogen by the U.S. Environmental Protection Agency.[58] A study conducted by the National Toxicology Program found that after exposure to high levels of Deca, cancers of the liver, thyroid and pancreas were found in both mice and rats.[59] While the doses were high, the actual absorption of Deca was approximately 1/1000 of the doses. This suggests that Deca could be carcinogenic at lower exposure levels. Unfortunately no further studies have been conducted to examine this possibility.

Deca Breaks Down into Other PBDEs

Studies confirm that Deca breaks down into components present in Octa and Penta. The degradation of Deca can occur as a result of exposure to sunlight, bacteria in anaerobic environments, and through the metabolic process of animals.[60]

Studies of Deca in rainbow trout showed that Deca breaks down into components of Octa and Nona, and Deca in carp has been shown to break down into components of Penta and Hexa.[61,62] Octa and Nona have also been found to be break down products of Deca in rats.[63]

Deca has also been found to degrade in sewage sludge and soil, with components of Hexa, Hepta, Octa and Nona being formed.[64,65] The fact that these lower-brominated PBDEs are in sewage sludge and soil increases the chance that they will make their way through the environment and end up in fish, wildlife and even people.

Vermont's Fire Fighter Protection Act of 2007

The Vermont Legislature has already taken steps to protect the health of fire fighters by passing one of the strongest cancer presumption laws in the country. Under this law, it is presumed that fire fighters who are diagnosed with certain cancers have fallen ill due to their exposure to carcinogens and toxins while on the job.

ALTERNATIVES TO DECA

Safer and effective alternatives to Deca are available.

Safer and effective alternatives to Deca are available. Fire safety standards for televisions, computers, mattresses, furniture, and other products can be achieved without Deca by using non-chemical and chemical substitutes.

Non-chemical alternatives to Deca can include the redesign of a product or the use of materials that are inherently more flame resistant. For example, in electronic equipment, metal components could be used to protect the power supply. And with textiles, easily ignitable fabrics such as cotton could be replaced with materials that are difficult to ignite or burn more slowly (such as nylon, silk, and wool).[66]

Fire safety standards can also be met by using chemical alternatives to Deca. For example, a phosphorous-based compound called resocinol bis diphenyl phosphate (RDP) is a common substitute for Deca in electronics. According to the Maine Department of Environmental Protection and Center for Disease Control and Prevention, "RDP presents a significantly lower threat to the environment and human health than decaBDE."[67]

57% of TVs and 95% of computers are already Deca-free.

Electronics

Approximately 80% of Deca used in the United States is in electronics, with the vast majority used in the plastic casings of televisions.[68] The use of Deca in computer monitors is extremely rare. According to Washington State, 95% of computer products are Deca-free.[69]

Replacing Deca in Televisions

Fire safety standards for plastics in electronics are guided by the National Fire Protection Association (NFPA) along with the Underwriter's Laboratory (UL). Although the standards are voluntary, they are often referred to by federal and state regulations as "a definitive source for fire and combustion related technical information."[70] In addition, most manufacturers willingly choose to meet the NFPA standards to minimize product liability concerns.

The UL standard for TV enclosures requires the UL94 V-0 rating for any plastic within two inches of an ignition source. This is a vertical burn test where five vertically mounted samples of plastic are exposed to two consecutive ten-second ignitions from an open flame. The UL 94 V-0 rating, one of the most stringent, means that:

- The extinguishment time for each sample does not exceed 10 seconds
- The total combustion time for all five samples does not exceed 50 seconds
- The afterglow time per sample does not exceed 30 seconds
- There were no flaming drips
- No burning occurred up to the holding clamps

If a plastic can meet this standard, than it is considered fire safe, regardless of which flame retardant is used or whether one is used at all.[71] Deca-free televisions that meet the UL94 V-0 are already on the market. In fact, 57% of televisions are already Deca-free.[72]

Textiles
Flame retardants have been commonly used in textiles such as mattresses, drapery and upholstered furniture. In fact, textiles comprise the second largest use of Deca in the country. However, the current trend is moving away from Deca.

Leading mattress manufacturers including Sealy, Simmons, Serta, and Tempur-Pedic do not use Deca.

Mattresses
Mattress manufacturers have shifted away from the use of Deca and are instead choosing from two different options. The first is adding non-halogen, phosphorus-based flame retardants to mattress fabrics. The second option is using a barrier layer of flame-resistant material between the external fabric of the mattress and the more flammable inner cushioning.[73] Leading mattress manufacturers including Sealy, Simmons, Serta, and Tempur-Pedic do not use Deca.[74]

Upholstered Furniture
Deca is not currently used in residential upholstered furniture and "furniture industry sources suggest that, in 99% of cases, chemical flame retardants will not be needed to meet pending national standards for residential upholstered furniture."[75]

Many electronics manufacturers have already removed Deca from their products including:

- **Sony**
- **Apple**
- **LG Electronics**
- **Sharp**
- **Dell**
- **Samsung**
- **Lenovo**
- **Hewlett Packard**
- **Panasonic**
- **Phillips**
- **Toshiba Personal Computing**

Source: Clean Production Action. *Progress Towards PVC and BFR Elimination by Leading Electronic Manufacturers Selling Products in the US,* February 2008.

Voluntary Market Changes
The market is trending away from the use of Deca and decisions made by leading electronics and mattress companies reflect that.

Apple, Dell, Lenovo, Acer, Sony, LG Electronics, Samsung, Sharp, Phillips, and Toshiba Personal Computing have committed to completely eliminating Deca and all other brominated flame retardants from their products.[76]

In addition, the majority of the top bedding manufacturers in the United States do not use Deca in their mattresses. This includes Sealy, Simmons, Serta, Tempur-Pedic, Select Comfort, King Koil, Kingsdown, Englander, International Bedding Corp, Restonic, Corsicana, and Lady Americana.[77]

CURRENT REGULATIONS

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was passed in 1976 to provide a framework for the regulation of chemicals at the federal level. TSCA was intended to protect the environment and health from "unreasonable" risk and to push manufacturers to collect the data needed to do this. Unfortunately, TSCA has failed to protect public health and the environment, and is considered by many to be the most ineffective environmental law in the country.

At the time of passage, TSCA allowed over 60,000 chemicals to be "grandfathered" in without requiring any data on toxicity. For new and emerging chemicals, TSCA puts the burden on the U.S. EPA to prove that a chemical may cause harm to human health or the environment. This creates a Catch-22 where the EPA must "already *have* data in order to require testing to *develop* data to determine the safety of chemicals."[78]

TSCA's ineffectiveness in protecting the public from more than 80,000 chemicals in commerce is evident. In the 32 years since TSCA's passage, the EPA has required testing for only 200 chemicals.

TSCA's ineffectiveness in protecting the public from more than 80,000 chemicals in commerce is evident. In the 32 years since TSCA's passage, the EPA has required testing for only 200 chemicals. The agency has only banned 5 chemicals or classes of chemicals (PCBs, chlorofluorocarbons, dioxin, asbestos, and hexavalent chromium).[79] No action has been taken at the federal level to restrict the use of PBDEs.

Banning PBDEs: States Taking the Lead

Inaction at the federal level has put the responsibility of protecting the public from PBDEs on the shoulders of individual states.

In 2003, California banned Penta and Octa. Since then 10 other states have followed suit including Hawaii, Illinois, Maine, Maryland, Michigan, Minnesota, New York, Oregon, Rhode Island and Washington.

Quick Facts:

- **Eleven states including California, Maine, and New York have banned Penta and Octa**
- **Maine and Washington State have restricted the use of Deca**
- **In 2007 to 2008, eleven states including Connecticut, Maryland, and New York introduced legislation to ban Deca**

In April of 2007 Washington became the first state to ban Deca. Washington's law banned Deca from mattresses by 2008. With regard to TVs, computers, and residential furniture, the law first required the State's departments of Ecology and Health to determine that alternatives were less toxic and equally effective. This report was recently released and approved by the State's Fire Safety Committee and Fire Marshal. Approval of the report triggered a ban on the manufacture, sale and distribution of TVs, computers, and residential upholstered furniture containing Deca-BDE by January 2011.

Maine banned Deca in June of 2007. New uses of Deca in mattresses and upholstered furniture were banned effective January 1, 2008. The law also calls for a phase-out of Deca in TVs and computer housings by January 2010. The state also has the ability to adopt rules to ban other harmful flame retardants from mattresses, upholstered furniture, TVs and computers if safer alternatives exist that meet fire safety standards.

Other states are following in the footsteps of Maine and Washington. In 2007 to 2008, eleven states introduced legislation to ban Deca including Alaska, California, Connecticut, Hawaii, Illinois, Maryland, Michigan, Minnesota, Montana, New York and Vermont.

Europe Takes a Precautionary Approach

The European Union (EU) which consists of 27 countries and nearly 500 million people is far ahead of the United States in its regulation of PBDEs. In 2003, the EU issued a directive that banned Penta and

Octa.[80] That same year, the EU sent shockwaves around the world when they passed the directive on the Restriction of Certain Hazardous Substances to Electrical and Electronic Equipment (RoHS).

The RoHS directive severely limits the levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBBs), and polybrominated diphenyl ethers (PBDEs) that can be used in new electrical and electronic equipment. Manufacturers that do not comply with RoHS lose access to the European market.[81]

The banning of PBDEs under RoHS was to take effect on July 1, 2006. However, in October of 2005, the European Commission excluded Deca from the ban.[82] This decision was challenged by the European Parliament and Denmark, with Portugal, Finland, Sweden and Norway intervening in the lawsuit. To be excluded from RoHS, it would have to be determined that the elimination of Deca was technically impractical or that the negative environmental, health or consumer safety impacts caused by substitution were likely to outweigh the benefits. On April 1, 2008 the Court of Justice ruled against the European Commission and reinstated the ban of Deca.[83]

In addition to RoHS, Europe also enacted the Registration, Evaluation, Authorization, and Restriction of Chemical Substances (REACH). REACH is guided by the precautionary principle and covers all chemicals manufactured in or imported into the European Union.[84] This regulation strengthens the protection of human health and the environment through better and earlier identification of chemical properties. Greater responsibility is now on the industry to manage the risks from chemicals and to provide safety information. REACH also requires the replacement of chemicals of high concern when suitable alternatives are identified.

Wingspread Statement on the Precautionary Principle

When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

In this context the proponent of an activity, rather than the public, should bear the burden of proof.

The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.

Source: Wingspread Statement on the Precautionary Principle, January 1998. Available at: http://www.sehn.org/state.html#w

RECOMMENDATIONS FOR VERMONT

Vermont must take steps to protect public health and the environment from exposure to toxic flame retardants. Safer and equally effective alternatives to Penta, Octa, and Deca exist. Vermont should look to Maine and Washington as models for reducing our exposure to PBDEs and prohibiting the use of Deca in mattresses, residential upholstered furniture, and the plastic casings of televisions and computers.

In addition, Vermont should look beyond addressing chemicals on an individual basis. Instead, we must take a comprehensive approach to chemical regulation that uses precaution and acts when there is evidence of harm. Other states including Maine and Washington have already passed legislation that provides a framework for addressing chemicals of high concern. Vermont should do the same.

Conclusion

PBDEs including Deca are accumulating in our bodies, food, homes and environment. Americans and children are particularly vulnerable to exposure to PBDEs. This is especially troubling given the toxicity of Deca and its ability to degrade into more dangerous congeners including Penta and Octa.

The failed national policy of the federal government has allowed Deca and other chemicals to be put on the market without any data concerning safety. Chemicals in the United States are assumed safe unless proven otherwise. As a result, tens of thousands of chemicals are being used in this country, potentially endangering the health and wellbeing of people and the environment.

This void of federal leadership has left states to fend for themselves and it is time that Vermont take action. The State of Vermont should immediately prohibit the use of Penta, Octa, and Deca, and should put in place a comprehensive framework for broader chemical reform.

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