

## Polybrominated Diphenyl Ethers (PBDEs)

### WHAT ARE PBDEs?

Polybrominated diphenyl ethers, or PBDEs, are a class of flame retardant chemicals added to many consumer products found in the home, office, automobiles, and airplanes.<sup>1</sup> Three mixtures used widely—penta-BDE, octa-BDE, and deca-BDE—made up 14%, 6%, and 80% of the 1999 worldwide production, respectively.<sup>2</sup> Usually found in electronics, such as TVs, and used in some furniture foams, fabrics, and kitchen appliances, the industry voluntarily ended production in the United States of the formulations of penta and octa in 2004 after high levels were found in breast milk. However, the deca formulation is still being produced and used mostly in plastic electronics such as televisions and computer casings. It is also used in the upholstery covers of items such as furniture, mattresses, and car seats.<sup>3,4</sup>

PBDEs are also part of a larger chemical class called polyhalogenated aromatic hydrocarbons (PHAHs) which include other highly toxic chemicals such as polychlorinated biphenyls (PCBs) and dioxins.<sup>2</sup> PBDEs are intrinsically hazardous because of their chemical make-up: (1) they are stable, meaning they stay in the environment and do not break down easily; (2) they are lipophilic, meaning they build up in fatty tissues of living organisms; and (3) they have toxic properties, including the potential to act as endocrine disruptors.<sup>5</sup> Their persistence and fat solubility allow them to both biomagnify and bioaccumulate, meaning they build up in

the bodies of animals and humans as they move through the food chain. Although the main component in deca-BDE, BDE-209, has a relatively short half-life in people,<sup>1</sup> animal studies show that the liver breaks down BDE-209 into the more persistent and bioaccumulative formulations known as hepta-BDE, octa-BDE, and nona-BDE.<sup>6,7</sup>

### HOW ARE WE EXPOSED?

There are many ways that humans are exposed to PBDEs, including eating contaminated foods and incidental intake of PBDE-contaminated dust.<sup>7</sup> Because of the chemical make-up of PBDEs, they do not fully attach to the products in which they are used. Deca, in particular, breaks down into more toxic products and volatilizes when exposed to ultraviolet (UV) light.<sup>8</sup> It is not entirely clear how deca is being released from products, though some think it might be released from physical abrasion or deterioration of the product. Penta does not need UV light exposure to volatilize. PBDEs are released from furniture, electronics and other products when exposed to UV light, causing them to be present in the air we breathe and in dust. Although penta-BDE and octa-BDE are no longer produced in the United States, exposure continues from old computers, furniture, fabrics, and other consumer sources that were made before the discontinuation.<sup>9</sup>

Out of all possible exposure routes, the highest intake of deca-BDE results from household dust.<sup>10,11,12</sup> Another major route

of exposure is eating fatty foods such as meat and dairy products,<sup>13</sup> as PBDEs are fat-seeking and build up in the food chain.

Eating fish and marine animals may be another route of exposure because they have been found to contain high levels of deca-BDE.<sup>14</sup> The high levels in marine environments may be due to atmospheric deposition (when contaminants from the air come down to the earth's surface by rain, snow, falling particles, and the absorption of gas) of deca-BDE as well as sewage discharge into the oceans.<sup>14</sup>

### **PBDEs IN OUR BODIES**

Due to their widespread use, persistence and bioaccumulative properties, PBDEs have been found in humans at high levels. One study showed that 5 percent of American women have levels of PBDEs that are close to the levels linked to reproductive problems in animals,<sup>1</sup> though we do not know if humans are more or less sensitive than animals. PBDEs have been found in mothers' breast milk and in the blood of mothers and their babies.<sup>15,16</sup> People of the Arctic may experience an even higher risk due to their traditional diet rich in fat from marine mammals.<sup>7</sup> Concentrations of PBDEs have grown over the years in marine mammals due to atmospheric transport (transported long distances from areas of production and use via air and ocean currents into the north) and bioaccumulation.<sup>2</sup>

### **WHAT DOES EXPOSURE TO PBDEs MEAN FOR OUR HEALTH?**

PBDEs have been linked to many adverse health effects, including:

#### **Developmental Effects:**

Studies in rodents suggest that neonatal exposure to PBDEs permanently affects learning and memory functions, impairs motor activity, and is linked to aberrations in spontaneous behavior and hyperactivity that seem to be permanent.<sup>17,18,19</sup> However, it is not known what the

developmental effects are in people or at what doses they happen.

#### **Reproductive Effects:**

PBDEs are mildly estrogenic compounds<sup>20</sup> which have been correlated to cryptorchidism, or undescended testes, in newborn boys,<sup>21</sup> and shown to permanently impair sperm development in rodent studies.<sup>11</sup> Exposure to PBDEs in household dust is linked with lower levels of androgens (male hormones) in adult men.<sup>22</sup> PBDEs have also been associated with delay of puberty in both male and female rodents and changes in sexual development and gender-specific sexual behavior.<sup>23</sup> Exposure to PBDEs has also been linked to low birth weight, birth defects, reduced weight gain during pregnancy, changes in ovary cells, and reduced sperm count.<sup>24,25</sup> The breakdown products of PBDEs also may inhibit aromatase, an enzyme important in the formation of androgens and estrogens (male and female hormones),<sup>26</sup> and in the skeletal development of both males and females.

#### **Cancer:**

One study suggests that *in utero* exposure to PBDE concentrations is associated with an increased risk of testicular cancer in men.<sup>27</sup> The Agency for Toxic Substances and Disease Registry (ATSDR) lists deca-BDE as a possible human carcinogen based on the development of liver tumors in rats that were given the substance.<sup>7</sup>

#### **Thyroid Problems:**

In a study of newborn babies, high PBDE levels in cord blood are associated with decreased levels of thyroid hormones.<sup>28</sup> Corresponding animal studies have also shown that PBDE exposure is linked to decreased circulating concentrations of thyroid hormone<sup>11,29</sup> and decreased thyroid weight in adult rodent offspring.<sup>13</sup>

## REGULATIONS FOR PBDES

There have been many steps forward in the regulation of PBDEs in recent years, but much more is needed to ensure the safety of public health. Internationally, Sweden was the first to initiate a phase-out of PBDEs in the late 1990s, followed by the European Union—first phasing out penta-BDE and octa-BDE and then deca-BDE in 2006.<sup>30</sup> In 2008, Norway banned the use of deca-BDE in new consumer products,<sup>31</sup>

and Canada prohibited the manufacture of all PBDEs and put in place restrictions on the import of certain PBDEs.<sup>32</sup> In the United States, industry voluntarily ended production of penta-BDE and octa-BDE in 2004, but deca-BDE is still allowed to be used in consumer products.<sup>16</sup> Both Washington and Maine are currently discontinuing the use and manufacture of deca-BDE,<sup>33,34</sup> with other states around the nation aiming for similar legislation.

## REDUCING OUR EXPOSURE

You can minimize your exposure to PBDEs by taking the following steps:

### PBDE-free Furniture:

- Before purchasing furniture, find out which companies offer PBDE-free products. The following websites can help:
  - Clean Production Action: [www.cleanproduction.org/Flame.Alternatives.php](http://www.cleanproduction.org/Flame.Alternatives.php)
  - Pollution in People: [www.pollutioninpeople.org/safer/products](http://www.pollutioninpeople.org/safer/products)
- Contact the company directly if you cannot figure out if the manufacturer uses PBDEs.
- Choose furniture made with less flammable fabrics like leather, wool and cotton.

### PBDEs in Foam Padding:

- Foam items purchased before 2005 are likely to contain PBDEs. Make sure these items are completely covered in fabric with no rips.
- Avoid reupholstering foam furniture.
- Be very careful when removing old carpet. Try to keep your work area separated from the rest of the house and thoroughly clean up the area.

### Reduce Your Dust Exposure:

- Wash your hands often to remove dust particles that your hands pick up throughout the day on everything you touch.
- Use a wet rag or cloth while dusting to avoid kicking up the dust in the air.
- If possible, use a vacuum fitted with a HEPA filter. These vacuums can trap smaller particles of dust and will be more likely to remove contaminants from your home.
- Vehicles have been exempt from recent PBDE laws and high levels have been found inside cars.<sup>4</sup> Removing dust with a wet cloth and keeping car seat cushions in good repair will help to reduce your exposure.

### PBDE-free Electronics:

- Many companies are beginning to make electronics with alternatives to PBDEs. Certain PBDE-free products are available from Canon, Dell, HP, Intel, Erickson, Apple, Acer, Nokia, Motorola, LG Electronics, and Sony.

### Consider Eating Less Fat:

- Consider choosing leaner meat and poultry cuts.
- Consider removing fat that you see on meat and fish whenever possible.
- Choose cooking methods that remove excess fat such as broiling, grilling, and roasting.

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