

Flame Retardants

What are flame retardants?

Flame retardants are chemicals that are added or applied to materials in order to slow or prevent the start or growth of fire.

Where are flame retardants used?

Flame retardants have been used in many consumer and industrial products since the 1970s, to decrease the ability of materials to ignite. Flame retardants are often added or applied to the following products.

Furnishings, such as foam, upholstery, mattresses, carpets, curtains, and fabric blinds.

Electronics and electrical devices, such as computers, laptops, phones, televisions, household appliances, and wires and cables.

Building and construction materials, including electrical wires and cables, and insulation materials, such as polystyrene and polyurethane insulation foams.

Transportation products, such as seats, seat covers and fillings, bumpers, overhead compartments, and other parts of automobiles, airplanes, and trains.

Many flame retardants have been removed from the market or are no longer produced. However, because they do not easily break down, they can remain persistent in the environment for years. They can also bioaccumulate, or build up in people and animals over time.

How are people exposed to flame retardants?

People can be exposed to flame retardants through a variety of ways, including diet; consumer products in the home, car, airplane, and workplace; and house dust.¹

- These chemicals can get into the air, water, and soil during manufacture.
- Chemicals can leak from products into dust and into the air.
- Dust can get on hands and food and then into the mouth when food is eaten.
- Through e-waste or the uncontrolled burning and dismantling of electronic and electric waste.



What are some of the potential health effects associated with flame retardants?

Although flame retardants can offer benefits when they are added to some products, a growing body of evidence shows that many of these chemicals are associated with adverse health effects in animals and humans, including endocrine and thyroid disruption, impacts to the immune system, reproductive toxicity, cancer, and adverse effects on fetal and child development and neurologic function.²

Who is most vulnerable?

Children may be particularly vulnerable to the toxic effects of these chemicals, because their brain and other organs are still developing. Hand-to-mouth behavior and proximity to the floor increases the potential of children to be exposed to flame retardants. Researchers have found that children have higher concentrations of flame retardants in their bodies than adults.³

There are hundreds of different flame retardants. They are often broken into categories based on chemical structure and properties. Brominated flame retardants and organophosphorus flame retardants are two types of commonly used flame retardants.

Why are NIEHS and NTP studying these chemicals?

Flame retardants are being studied because of their abundance in the environment and concerns about their impact on human health, especially to children who can be easily exposed to them through hand-to-mouth contact.

There is growing evidence that many flame retardant chemicals can affect the endocrine, immune, reproductive, and nervous systems. Some animal studies have shown that long-term exposure to flame retardants can lead to cancer.



Researchers are also beginning to look at the potential association between flame retardants and other health outcomes, including thyroid disruption and obesity, and the role they may be playing in human development. More research needs to be done to understand the effect these chemicals are having on human health.

The National Toxicology Program, an interagency testing program headquartered at NIEHS, has received many nominations to study flame retardants, because of the lack of information about their toxicity.

NIEHS is also interested in conducting research and sharing new findings that will help companies develop safer alternatives to current flame retardants.

NIEHS needs to better understand how people dispose of products that contain flame retardants. For example, at sites where discarded consumer products containing flame retardants are dismantled, recycled, or burned, there is potential for release of these products into the air, soil, and water. These chemicals can then be absorbed by surrounding vegetation, animals, or people.⁴

NIEHS Superfund researchers and others are working to find better solutions to reduce exposure to e-waste that will not harm people or the environment.

Are there different types of flame retardants? What do we know about them?

There are hundreds of different flame retardants. They are often broken into categories based on chemical structure and properties. In general, flame retardants are grouped based on whether they contain bromine, chlorine, phosphorus, nitrogen, metals, or boron.

Brominated flame retardants. These chemicals contain bromine and are the most abundantly used flame retardants. They are used in many types of consumer goods, including electronics, furniture, building materials, and automobiles, to slow or prevent the start or growth of fire. Brominated flame retardants have been shown to have many effects on the body, including disruption of the endocrine system.⁵

• Polybrominated diphenyl ethers (PBDE's).

This group of industrial chemicals was added to consumer products to meet flammability standards in the 1970s, after another similar product, polybrominated biphenyls, was taken off the market. PBDEs do not chemically bind to the products to which they are added, such as furniture and electronics, so they easily release from these products and get into air and dust. They can also enter the environment through manufacturing, wearing down of products during use, and product disposal. Researchers have found that PBDEs can lower birth weight and length of children, and impair neurological development.⁶ In animal studies conducted by NTP, several PBDEs have been shown to cause cancer.^{7,8} While PBDEs have been banned or phased out of production, they still remain persistent in the environment.



- **Tetrabromobisphenol A (TBBPA).** This chemical is widely used to make computer circuit boards and other electronics. It is also used in some textiles and paper, and may be used as an additive to make other flame retardants. TBBPA is currently the world's most highly produced brominated flame retardant,⁹ making human exposure to it widespread. It has been found in human tissue, and household dust, as well as other places in the environment, including soil, water, and fish. TBBPA appears to have endocrine-disrupting properties.¹⁰ NTP completed the first-ever two-year cancer study of this flame retardant in both mice and rats, and found that it caused cancers of the uterus in female rats and liver in male mice.¹¹ NTP studies are designed to identify substances that may present a cancer hazard to humans. In-house researchers at NIEHS are also looking at developmental outcomes from early life exposures to TBBPA.
- **Hexabromocyclododecane (HBCD).** This flame retardant is an additive primarily used in polystyrene foam building materials. The primary risk to humans is from leaching out of products and getting into indoor dust. Low levels of HBCD have also been found in some food products.¹² It has been shown to have effects on the brain, and immune and reproductive systems, and to cause endocrine disruption in animals.

Organophosphate flame retardants (OPFRs).

With the phasing out of PBDEs, some OPFRs have been identified as replacements. NTP is currently working on a program to compare and contrast the activity of these replacement halogenated and non-halogenated OPFRs with the phased-out PBDEs, and to generate some data on potential hazards. NTP has completed screening studies *in vitro* and in alternative animal models. Findings show that some of these replacement OPFRs have activity comparable to the phased-out PBDEs.¹³ NTP is currently conducting developmental neurotoxicity studies *in vivo* on some representative OPFRs, due to structural similarities with organophosphorus insecticides, which are known to be neurotoxic.

Other flame retardants

There are other types of flame retardants that are still being found worldwide. For example, the chlorinated organophosphate tris(1,3-dichloro-2-propyl)phosphate (TDCPP) has been linked to cancer in rats,¹⁴ and has been shown to be present in people,¹⁵ and in dust from homes, offices, and automobiles.¹⁶

NIEHS-supported researchers are also looking at the health effects of newer flame retardant alternatives that are being brought to market. For example, some scientists are researching Firemaster 550.



This product was used as an alternative to pentaBDE, which was phased out. The researchers found that some of the components in this product caused endocrine and metabolic effects in rats and may lead to obesity and an increase in the onset of puberty.¹⁷ NIH researchers are continuing to study these newer commercial mixtures to determine how they are metabolized in the body and to determine whether they may cause adverse health effects.

Overview of NTP studies

NTP has generated data on many flame retardants. The compounds chosen for study included the most commonly used flame retardants, those thought to be most hazardous, and some newer flame retardants, such as the organophosphorus flame retardants, which are replacing some PBDEs. NTP is using a variety of approaches to find out more about these compounds.¹³

Grantee-funded research

In addition to NTP efforts, NIEHS-funded grantees across the country are conducting research on flame retardants. For example, some are looking at the role that newly introduced fire retardant mixtures may be playing in our nation's increase in metabolic disorders, such as hypertension, diabetes, and obesity. Researchers are also looking at the health effects replacement flame retardants may be having on pregnant woman and children who live in California, where stricter flammability standards have resulted in very high flame retardant exposures. Others are looking at how a mother and father's exposure to flame retardants might affect pregnancy outcomes.

What can be done to reduce exposure to flame retardants?

- Keep dust levels down, by wet mopping and vacuuming with a high efficiency particulate air (HEPA) filter to help remove contaminants from your home.
- Wash your hands and those of your children often. Hand-to-mouth contact exposes people to flame retardants.
- When purchasing new products, try to purchase baby products and furniture filled with cotton, polyester, or wool, instead of polyurethane foam.
- Reduce dust by having a good ventilation system in your home.

Where can I go for more information?

National Toxicology Program
<http://ntp.niehs.nih.gov>

Centers for Disease Control and Prevention
http://www.cdc.gov/biomonitoring/PBDEs_FactSheet.html

Consumer Product Safety Commission
<http://www.cpsc.gov/en/Research--Statistics/Chemicals/Flame-Retardants>

U.S. Environmental Protection Agency
<https://www.epa.gov/saferchoice/consumer-fact-sheet-flame-retardants>



For more information on the National Institute of Environmental Health Sciences, go to www.niehs.nih.gov.

Citations

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