Flame Retardants and Your Health

What are flame retardants?

Flame retardants are various chemicals applied to materials to prevent burning or slow the spread of fire. The term applies to the function, not a specific composition, of such chemicals.

Where are flame retardants used?

Since the 1970s, flame-retardant chemicals have been added to many types of products:

- **Furnishings**, such as seating foam and coverings (including transport vehicles), mattresses, and carpets.
- **Electronics and electrical devices**, such as computers, phones, televisions, and household appliances.
- **Building and construction materials**, such as coatings for electrical wires and cables, polystyrene foams, and polyurethane insulation such as spray foams.

Because these chemicals do not easily break down, they can remain in the environment and in a body[1] for years. Studies have shown that some may be hazardous to people and animals.

How are people exposed?

People can come in contact with flame retardants in a variety of ways.

- Chemicals can leach from products and into dust, food, and water, which can be ingested.
- Chemicals seep into the air, water, and soil during manufacturing or application.
- Similarly, the burning or dismantling of electrical and electronic waste (e-waste), can contaminate the environment with these chemicals, particularly in low- and middle-income countries.[2]

What are some potential health effects associated with flame retardants?

Learning how these chemicals, and in what amounts, may cause human health effects is an area of active research. Although flame retardants can offer benefits when added to certain products, increasing scientific evidence shows that many of these chemicals may harm animals and humans.

Adverse health effects may include endocrine and thyroid disruption, immunotoxicity, reproductive toxicity, cancer, and adverse effects on fetal and child development and neurologic function.[3]

Who is most vulnerable?

Children are more vulnerable to toxic effects because their brains and other organs are still developing. Hand-to-mouth behavior and play that is close to the floor increases the potential of children to come in contact with harmful chemicals.

Chronic exposure to flame retardants in the general population, as well as evidence of neurotoxicity from animal studies, raises concern for neurodevelopmental effects in people. Some are associated with impaired cognitive and behavioral development in children.[4]

PO Box 12233 • Research Triangle Park, NC 27709
Phone: 919-541-3345 • **https://niehs.nih.gov**

National Institutes of Health
U.S. Department of Health and Human Services

April 2023

♲ Printed on recycled paper

What is NIEHS doing?

Within NIEHS, several programs study flame retardants. The types chosen for study tend to be those most used and thought to be most hazardous, along with some newer compounds. Scientists use a variety of approaches and seek to assess potential hazards across classes of flame retardants, instead of testing one chemical at a time.

In addition, several NIEHS-funded grantees are looking at the role that newly introduced flame-retardant mixtures may play in metabolic disorders such as obesity[5] and hypertension. Others are looking at how maternal and paternal exposure to flame retardants might affect reproduction and genes critical to proper human development.[6]

NIEHS is also investigating different ways to dispose of products that contain flame retardants. And the institute supports research that will help companies develop safer alternatives to current flame retardants.

What is known about different types of flame retardants?

The hundreds of different flame retardants are often grouped according to chemical structure and properties. In general, such groups may be based on whether the flame retardant contains bromine, chlorine, phosphorus, nitrogen, metals, or boron. A few types are described here.

- **Brominated flame retardants (BFRs)** contain bromine and are used in many electronics, furniture, and building materials. BFRs have been linked to endocrine disruption and thyroid disfunction.[7] Older compounds have been replaced by new versions that also show toxic endocrine effects.[8]
- **Hexabromocyclododecane (HBCD)** is a brominated flame-retardant additive used primarily in polystyrene foam building materials. Health concerns include alterations in immune and reproductive systems, neurotoxic effects, and endocrine disruption.[9]

- **Organophosphate flame retardants (OPFRs)** are widely used in textiles, electronics, and industrial materials and as replacements for other types of flame retardants. Studies suggest these chemicals could pose a risk to bone[10] and brain[11] health.
- **Polybrominated diphenyl ethers (PBDEs)** do not chemically bind with the products to which they are added, such as furniture, and are easily released into air and dust. Production was phased out beginning in 2004. Despite phaseout, this compound is stabile in the environment and products containing PBDEs remain in use, suggesting exposure will continue for some time. A major effort has been devoted to evaluating potential health risks. Evidence links human exposure to neurodevelopmental disorders.[12]
- **Tetrabromobisphenol A (TBBPA)** is used in plastic paints, synthetic textiles, and electronic devices, and as an additive in other flame retardants. This compound was found to cause cancer in rats and mice.[13]

Research on flame retardants is ongoing. NIEHS-supported researchers are also looking at the health effects of newer flame-retardant alternatives.

For more information on the
National Institute of Environmental Health Sciences,
go to **https://niehs.nih.gov**.

1 Cowell WJ, et al. 2019. Temporal trends and developmental patterns of plasma polybrominated diphenyl ether concentrations over a 15-year period between 1998 and 2013. J Expo Sci Environ Epidemiol. 29(1):49-60.

2 Heacock M, et al. 2016. E-waste: the growing global problem and next steps. Rev Environ Health 31(1):131-135.

3 Shaw SD, et al. 2010. Halogenated flame retardants: do the fire safety benefits justify the risks? Rev Environ Health 25(4):261-305.

4 Vuong AM, et al. 2020. Flame retardants and neurodevelopment: An updated review of epidemiological literature. Curr Epidemiol Rep. 7(4):220-236.

5 Chappell VA, et al. 2018. Tetrabromobisphenol-A promotes early adipogenesis and lipogenesis in 3T3-L1 cells. Toxicol Sci 166(2):332–344.

6 Greeson KW, et al. 2020. Detrimental effects of flame retardant, PBB153, exposure on sperm and future generations. Sci Rep 10(1):8567.

7 Leonetti C, et al. 2016. Brominated flame retardants in placental tissues: associations with infant sex and thyroid hormone endpoints. Environ Health 15(1):113.

8 Dong L, et al. 2021. New understanding of novel brominated flame retardants (NBFRs): Neuro(endocrine) toxicity. Ecotoxicol Environ Saf 208:111570.

9 Schecter A, et al. 2012. Hexabromocyclododecane (HBCD) stereoisomers in U.S. food from Dallas, Texas. Environ Health Perspect 120(9):1260-1264.

10 Kuiper JR, et al. 2022. Early life organophosphate ester exposures and bone health at age 12 years: The Health Outcomes and Measures of the Environment (HOME) Study. Sci Total Environ 851(Pt 2):158246.

11 Rock KD, et al. 2020. Effects of Prenatal Exposure to a Mixture of Organophosphate Flame Retardants on Placental Gene Expression and Serotonergic Innervation in the Fetal Rat Brain. Toxicol Sci 1;176(1):203-223.

12 Poston RG, Saha RN. 2019. Epigenetic Effects of Polybrominated Diphenyl Ethers on Human Health. Int J Environ Res Public Health. 29;16(15):2703.

13 NTP (National Toxicology Program). 2014. Technical Report on the Toxicology Studies of Tetrabromobisphenol A (CAS No. 79-94-7) in F344/NTac Rats and B6C3F1/N Mice and Toxicology and Carcinogenesis Studies of Tetrabromobisphenol A in Wistar Han [Crl:WI(Han)] Rats and B6C3F1/N Mice (Gavage Studies). Available: http://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr587_508.pdf.