

Polystyrene, polyisocyanurate, and polyurethane are energy efficient insulation materials whose use in green buildings is increasing. However, due to building flammability codes, fire retardant chemicals (FRs) must be added. Many of the FRs currently in use are halogenated organic chemicals, meaning that they contain chlorine or bromine bonded to carbon. Most of these FRs have not been adequately evaluated for their impact on human health and the environment. When tested, many are found to be persistent, bioaccumulative, and/or toxic. Being persistent means that they do not break down into safer chemicals in the environment over months or years. Being bioaccumulative means that they accumulate in plants and animals, becoming more concentrated as they move up the food chain. Additionally, some of these FRs are carcinogens, mutagens, and/or reproductive, neurological, thyroid, and/or developmental toxicants.

**The impacts of exposure to fire retardant chemicals upon workers, human and animal health, building occupants, wildlife and the global environment should be considered when selecting insulation materials.**

- All **polystyrene foam insulation** used in building insulation (both XPS, such as Styrofoam, and EPS) is treated with hexabromocyclododecane, (**HBCD**), a persistent, bioaccumulative, and toxic fire retardant. This chemical was nominated for the first EU list of “Substances of Very High Concern” and for listing under the Stockholm convention. It is found in dust, sewage sludge, breast milk and body fluids, wildlife and the environment. About 90% of the use of HBCD is with polystyrene insulation, which is the probable source of the global contamination. HBCD is also used with fabrics and plastic;
- **Polyisocyanurate (polyurethane)** board often contains **TCPP** (tris (1-chloro-2-propyl) phosphate). While its toxicity in mammals appears to be limited, the effects of long-term exposure are unknown, and it is toxic in aquatic environments. Triethyl phosphate (TEP), a non-halogenated FR used in the EU, is a safer alternative.
- **Polyisocyanurate (polyurethane)** boards can contain up to ten percent “**blowing agents**”, which are usually volatile hydrocarbons or halogenated hydrocarbons. For example, Dow THERMAX(TM) Insulation board contains up to ten percent of TCPP and five percent 1-Bromopropane. The MSDS states that the blowing agent can cause central nervous system effects in humans and harm to male and female reproductive organs and the liver as well as interference with reproduction and fertility and toxicity to the fetus in animal studies.
- **Polyurethane spray foam (SPF)** formulations frequently contain a mixture of brominated and chlorinated compounds that form 10% to 20% of the finished foam by weight. Typical SPF products (e. g. Bayer Bayseal) are two-component systems, with the FRs in the polyol component (the "B-side component). The two components are mixed at the time of application.

The impact of long term and cumulative exposures to mixtures of such chemicals upon the health of workers, inhabitants of homes, and the environment is not known.

## Halogenated fire retardants are becoming widespread in the environment

Halogenated fire retardants (HFRs) can migrate out of furniture foam, electronics, fabric and other consumer products as well as foam insulation so humans are exposed to a “cocktail” of such toxins. Levels of HFRs are increasing in household dust, human blood and breast milk, and wild animals. The chemicals are widely distributed in the outdoor environment with the highest concentrations in the Arctic and marine mammals. Certain classes of brominated fire retardants, the polybrominated diphenyl ethers, have been banned for most applications, but other halogenated chemicals have replaced them.

## How to reduce the health and environmental hazard from FRs in insulation

- Develop design guidelines, green building credit systems, and codes to encourage designers to:
  - Consider the toxicity of insulation options when selecting insulation types.
  - Consider alternate pathways to attaining needed levels of fire safety, such as designing with fire barriers or other materials to reduce flammability.
- Encourage research and use of alternative, non-halogenated fire retardant additives such as sodium borate and triethyl phosphate (TEP).
- Support governmental programs to require full health testing of all chemicals before they are used.
- Question the use of halogenated flame retardants until a fire safety benefit is proven.

## Insulation Energy Efficiency and Fire Retardants

Insulation Type	R value	Fire Retardant	Likely HFR Impact
Fiberglass blanket or batt	3.2	non-flammable	No FR
High performance fiberglass batt	3.8	non-flammable	No FR
Loose-fill fiberglass	2.5	non-flammable	No FR
Loose-fill rock wool	2.8	non-flammable	No FR
Loose-fill cellulose	3.5	sodium borate 20%	Non toxic FR
Dense-pack cellulose	4.0	sodium borate 20%	Nontoxic FR
Cellulose batt	3.7	sodium borate 20%	Nontoxic FR
Expanded polystyrene board (EPS)	3.8	HBCD 0.7%	HBCD (toxic)
Extruded polystyrene board (XPS)	4.8	HBCD 2.5%	HBCD (toxic)
Polyisocyanurate board, unfaced	5.8	TCPP 5% – 10%, others	HFR (no info)
Polyisocyanurate board, foil-faced	7.0	TCPP 5% – 10%, others	HFR (no info)
Spray polyurethane foam (SPF)	5.9	FRs 15% – 20%	HFRs (often toxic)

Reference: Article by Paul Fiset - © 2008 <[http://www.umass.edu/bmatwt/publications/articles/cellulose\\_insulation.html](http://www.umass.edu/bmatwt/publications/articles/cellulose_insulation.html)>

### More information:

Green Science Policy Institute: <http://greensciencepolicy.org/non-toxic-building-materials>  
Green Build Talk at

Healthy Building Network factsheet: Toxic Chemicals in Building Materials:  
[www.healthybuilding.net/healthcare/ToxicChemicalsInBuildingMaterials.pdf](http://www.healthybuilding.net/healthcare/ToxicChemicalsInBuildingMaterials.pdf)

Health Care without Harm fact sheets:

Flame Retardants: Alarming Increases in Humans and the Environment ([www.noharm.org/details.cfm?ID=1098](http://www.noharm.org/details.cfm?ID=1098))

Brominated Flame Retardants: Rising Levels of Concern ([www.noharm.org/details.cfm?id=1095](http://www.noharm.org/details.cfm?id=1095))

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