SILENT SPRING INSTITUTE

RESEARCHING THE ENVIRONMENT AND WOMEN'S HEALTH

29 Crafts Street, Newton MA 02458 617 332 4288 fax 617 332 4284
email info@silentspring.org www.silentspring.org

House Dust Contains Carcinogens and Untested Chemicals Used as Flame Retardants in Consumer Products

Study Fact Sheet: Northern California Household Exposure Study, Flame Retardant Follow Up

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Background

Consumer products such as furniture, textiles, and electronics often contain chemical flame retardants. These chemicals can come out of the products into house dust and the environment where people are exposed to them. House dust is a major source of exposure, particularly for children. Flame retardants have been detected in human blood, urine, breast milk, indoor and outdoor air, house dust, food, and wildlife around the world.

In 2003, Silent Spring Institute was the first to test US homes for the flame retardant PentaBDE, which was used in furniture foam. We discovered that household levels here were ten times higher than in Europe. Then in 2006, we discovered even higher levels of PentaBDE in California homes and in blood samples from California residents. The high levels in California are likely the result of a unique state-wide furniture flammability standard that is now being reconsidered because our study and others raised health concerns. PentaBDE was phased out by the US manufacturer in 2004 and banned from use in California, other states, and the European Union.

In addition to PentaBDE, many other chemicals are used as flame retardants in consumer products, including some identified as carcinogens. To understand how people are exposed to a whole range of flame retardant chemicals, we tested again in 2011 the California homes that we studied in 2006. **This is the first study to evaluate such a large number of chemical flame retardants in house dust, and the first to measure flame retardants in repeat house dust samples in the years after PentaBDE was phased out.**

What is the purpose of the study?

Earlier studies showed that PBDE flame retardants are released from consumer products, and people are exposed to them at levels that cause health concern. A variety of other chemicals are used as flame retardants, too. To learn about exposures to a wider range of flame retardants and find out how exposures have changed since PBDEs were banned, we measured many different types of flame retardants in dust samples collected from California homes.

What did we do?
We collected dust in 16 California homes in 2006 and again, in the same homes, in 2011. The dust samples were analyzed for 49 brominated flame retardants and organophosphate flame retardants as well as 13 "legacy" chemicals – persistent organochlorines (OCs) that were banned long ago (e.g., DDT). We analyzed which chemicals are found together, so we could learn more about mixtures and potential sources. To learn more about how product changes affect chemical levels in homes, we asked people whether they had added furniture, electronics, or flooring between the two times we tested their dust.

What chemicals did we test for and why?
We selected chemicals for testing based on evidence that they were widely used and may have harmful health effects. We included chemicals expected to be replacements for the phased out PBDEs. The uses and health concerns for chemicals we tested are shown in the attached Chemical Table. We tested for:

- 13 PBDE compounds that represent the three common commercial mixtures Penta-, Octa-, and DecaBDE.
- Firemaster® 550 chemicals
- hexabromocyclododecane (HBCYD), tetrabromobisphenol A (TBBPA) and other brominated flame retardants
- "Tris" -- chlorinated and brominated organophosphate flame retardants, including the chemical banned from children's pajamas in the 1970s.
- nonhalogenated organophosphate flame retardants.

For comparison, we also tested for legacy organochlorine chemicals including DDT and PCBs, to see how the levels of these long-banned chemicals changed between our sample collections in 2006 and 2011.

What did we find?

- Many different flame retardants were commonly found in the homes we studied. We found 55 target chemicals; 41 of them were in at least half of the homes. **The flame retardants in house dust include hormone disruptors, carcinogens, and chemicals with unknown safety profiles.**
- Chlorinated organophosphate flame retardants, including two (TCEP and TDCIPP or chlorinated "Tris") listed as carcinogens under California's Proposition 65, were found up to 0.01% in dust, higher than previously reported in the US.
- We detected TDBPP (brominated "Tris") in 75% of the homes. This chemical was banned in children's sleepwear in 1977 because of its potential to cause cancer. To our knowledge, this is the first report on TDBPP in house dust.
- Concentrations of six chemicals, including the carcinogens TCEP and TDCIPP, were higher than EPA health risk guidelines in at least one home; and levels in 13 of 16 homes exceeded at least one health guideline level.
- Levels of Firemaster® 550 components (EH-TBB, BEH-TBPH, and TPHP) increased from 2006 to 2011, likely because manufacturers are using it as a PentaBDE replacement.

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

- PentaBDE levels went down significantly in homes that added new furniture, electronics, and flooring, indicating exposure reductions when products were replaced after the PentaBDE phase-out. We found similar reductions in TBBPA in homes reporting new electronics. In contrast, people who added new furniture between sampling rounds had an increase in the chlorinated "Tris" chemical TCIPP, suggesting it is used as a PentaBDE replacement.
- Results indicate that exposure to flame retardants from house dust changed during the years of our study, after the phase-out of PentaBDE and OctaBDE. Manufacturers continue to use hazardous chemicals as flame retardants and to replace chemicals of concern with chemicals with uncharacterized toxicity.

The charts at the end of this Fact Sheet summarize the main findings.

What are the public health implications of the study?
Our study shows that California residents are exposed to a wide range of flame retardant chemicals in house dust, including some at levels of health concern. **Most homes had dust concentrations of at least one chemical above a health guideline. Earlier research shows that house dust is a major source of flame retardants in people's bodies and particularly in children.** Some of the chemicals with the highest levels in homes are carcinogens and are structurally similar to banned chemicals. Many of the detected chemicals show evidence of hormone disruption, in particular the PBDEs, HBCYD, and TBBPA affect thyroid hormone, which is important for brain development. The breakdown products of TDBPP (brominated "Tris") damage DNA and cause breast tumors in animal studies, raising concern about breast cancer in people. The structurally similar chlorinated "Tris" may show similar health effects.

Many of the FRs we found are produced in the US at > 1 million pounds/year, and despite these high production volumes, some have not yet been tested for safety. Current practices for putting flame retardants into products are inadequate to protect health.

How can individuals reduce their exposures to flame retardants?
- You can reduce your exposure to chemical flame retardants by selecting furnishings and building materials without chemical additives, for example, by selecting products made of naturally flame resistant materials such as wood and wool. Avoid installing foam padding under carpets, as this can also be a source.
- Make sure furniture made with foam is in good condition and foam is not exposed.
- Since many of these chemicals are found in house dust, keep dust levels low by using a vacuum cleaner with a HEPA filter and wiping surfaces with a wet cloth or mop.
- Wash hands frequently to minimize ingestion of contaminated dust.
- Additional suggestions to reduce chemical exposures are found at www.silentspring.org/take-action.

How can public policies reduce exposures to flame retardants?
Many of the chemicals in this study are added to furniture because of a state-wide furniture flammability standard in California (TB117), and furniture designed to meet the California rule is sold nationwide, so it affects exposures across the country. The most effective way to reduce

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

exposure is to change this rule. Other strategies can provide fire safety without dangerous chemicals. You can help make this happen by contacting California officials. Governor Brown recently directed state agencies to revise the state flammability standard and there will be ways for the public to get involved. For more information about how you can get involved, visit the Green Science Policy Institute website (www.greensciencepolicy.org).

At the national level, Congress is considering the Safe Chemicals Act to make sure chemicals in consumer products are safety tested before they go into use. To learn more, visit Safer Chemicals, Health Families (http://www.saferchemicals.org/). Europe is already adopting safer alternatives through REACH.

What are the limitations of the study?

This is one of the first studies to analyze for such a broad range of flame retardants in house dust and to analyze samples collected in the same home at two different time periods. However, we tested a small number of homes and might have learned more in a larger, longer study.

Our ability to link chemical levels with products used in the homes was limited, because our questionnaire relied on residents' recollections, and residents may have added flame retardant items that we didn't ask about, removed products without replacing them with new items, or failed to report on changes that we did ask about.

Finally, there are probably additional flame retardants used in consumer products that we did not include because they have not been disclosed by manufacturers.

Who funded this study?

The California Household Exposure Study was funded by the National Institute of Environmental Health Sciences (5R25ES13258), the New York Community Trust, the Fine Fund, and Art beCAUSE Breast Cancer Foundation.

How can I get more information?

Visit the Silent Spring Institute website at www.silentspring.org.

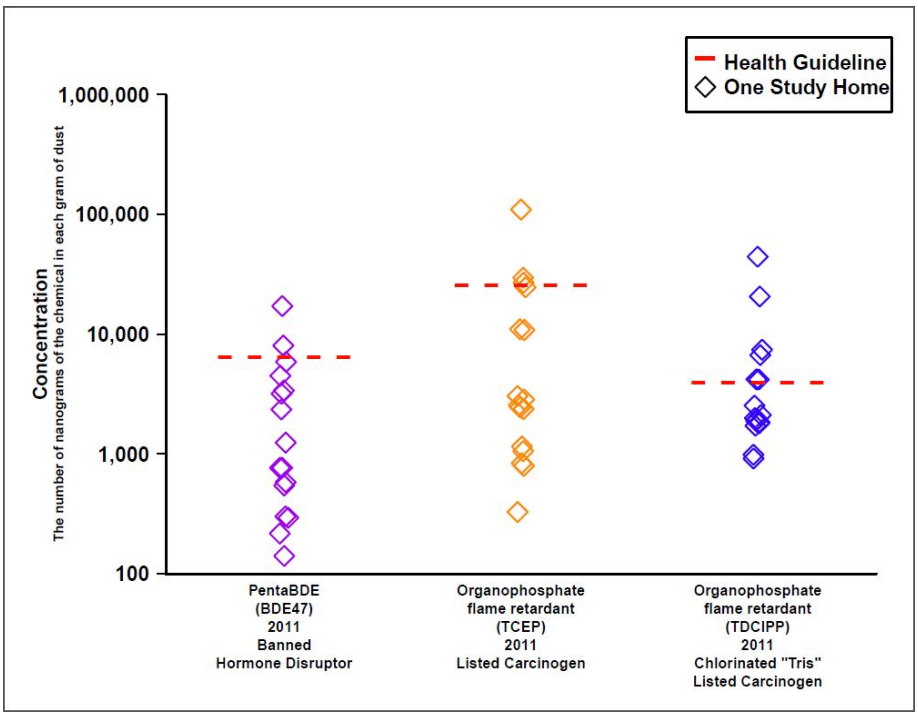
Scientists are in the process of revising the abbreviations for flame retardants; the following are notable changes:

Chemical Name	Old Abbreviation	New Abbreviation
Hexabromocyclododecane	HBCD	HBCYD
2-ethylhexyl-2,3,4,5-tetrabromobenzoate	TBB	EH-TBB
bis(2-ethylhexyl)-3,4,5,6-tetrabromophthalate	TBPH	BEH-TBEP
tri-phenyl phosphate	TPhP	TPHP
tris(1-chloro-2-propyl)-phosphate	TCPP	TCIPP
tris(1,3-dichloro-isopropyl)phosphate	TDCPP	TDCIPP

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

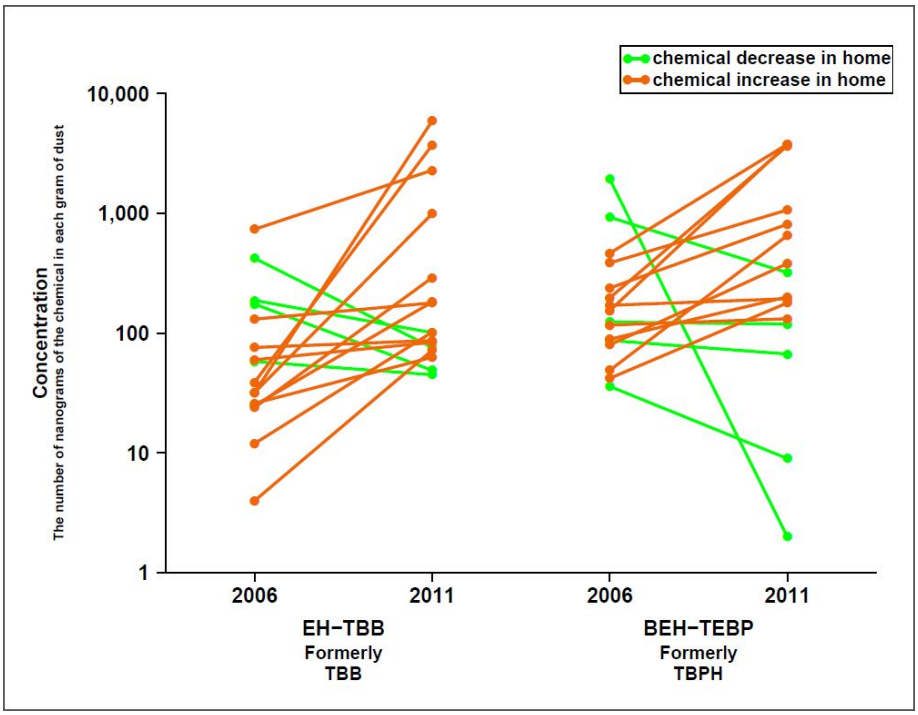
Main Findings: Northern California Household Exposure Study, Flame Retardant Follow Up

Chemical Levels in Some Homes Are Above Health Guidelines



House dust contains carcinogenic flame retardants including chlorinated "Tris." Levels in house dust are as high as the widely used PentaBDE, banned because of health concerns.

Firemaster® 550 Levels Are Increasing



Firemaster® 550 is a substitute for PentaBDE, which was phased out after 2004. These chemicals have not been tested for long-term health effects.

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Chemical Table: Northern California Household Exposure Study, Flame Retardant Follow Up

Chemical	How is it used?	How much is used in the US?[i] Is it Regulated?	Health Concerns[ii]
A. Polybrominated diphenyl ether flame retardants			
Pentabromodiphenyl ethers (PentaBDE) *Example: BDE 47*	Used in polyurethane foam	• Phased out in US in 2004 • EPA Action Plan Chemical	• Evidence of hormonal effects in humans • Evidence of developmental harm in humans • Can cause reproductive harm • Affects brain function
Octabromodiphenyl ethers (OctaBDE) *Example: BDE 183*	Used in polymers for plastic housings and office equipment	• Phased out in US in 2004	• Affects hormone systems • Affects brain function
Decabromodiphenyl ethers (DecaBDE) *BDE 209*	Used in electrical equipment, textiles and fabric backing; 80% of total PBDE production.	• 50-100 million pounds produced per year • Volunteer phase out in US by 2014	• Evidence of developmental harm in humans • Affects brain function • Can cause reproductive harm • Can cause cancer
B. Firemaster® 550 flame retardants			
Includes: 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EH-TBB) *Bis(2-ethylhexyl)-3,4,5,6-tetrabromophthalate (BEH-TBEP)* *Tri-phenyl phosphate (TPHP)*	Replacement for pentaBDE in foams	• 10-50 million pounds TPHP produced per year • 1-10 million pounds BEH-TBEP produced per year	• Evidence of reproductive harm in humans • Chemically similar to a phthalate (DEHP) that causes reproductive harm • DNA damage • Lack of health studies

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Chemical	How is it used?	How much is used in the US?[i] Is it Regulated?	Health Concerns[ii]
C. Hexabromocyclododecane flame retardants			
Hexabromocyclododecane (HBCYD)	Used in moldable polymers and styrene resins, building insulation, upholstery textiles and electrical equipment housing	• 10-50 million pounds produced per year • Substance of Very High Concern in Europe • EPA Action Plan Chemical	• Affects hormone systems • Affects brain function • Can cause developmental harm • Can cause reproductive harm
D. Tetrabromobisphenol A flame retardant			
Tetrabromobisphenol A (TBBPA)	Used in polymers; Most widely used flame retardant	• 100-500 million pounds produced per year	• Affects hormone systems • Affects brain function
E. Other brominated flame retardants			
Tetrabromobisphenol A-bis(2,3-dibromopropylether) (TBBPA-BDBPE)	Used in plastics, pipes, water barriers, kitchen hoods, and electronics.	• 1-10 million pounds produced per year	• Affects hormone systems • DNA damage • Lack of health studies
Hexabromobenzene (HBB)	Used in paper, wood, textiles, electronics and plastics; Not used in Europe.		• Blood and liver effects • Lack of health studies
1,2-bis(2,4,6-tribromophenoxy)ethane (BTBPE)	Replacement for OctaBDE	• 1-10 million pounds produced per year	• Affects hormone systems • Lack of health studies
Decabromodiphenylethane (DBDPE)	Alternative to DecaBDE	• 10-50 million pounds produced per year	• Can cause developmental harm • Chemically similar to DecaBDE • Lack of health studies

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Chemical	How is it used?	How much is used in the US?[i] Is it Regulated?	Health Concerns[ii]
F. Chlorinated and brominated organophosphate flame retardants (OPFRs)			
Tris-(2-chloroethyl)-phosphate (TCEP)	Used in polyurethane foam, plastics, polyester resins, and textiles; Banned from children's products in NY in 2011	• Up to 1 million pounds produced per year • Substance of Very High Concern in Europe	• Carcinogen • Evidence of effects on the brain in humans • Can cause reproductive harm
Tris-(1-chloro-2-propyl)-phosphate (TCIPP)	Used in polyurethane foam	• 10-50 million pounds produced per year	• Chemically similar to TCEP • Lack of health studies
Tris-(1,3-dichloro-2-propyl)phosphate (TDCIPP) *Known as chlorinated "Tris"*	Used in polyurethane foam, plastics, and textiles; Removed from children's sleepwear in late 1970s in the US	• 10-50 million pounds produced per year	• Carcinogen • Evidence of hormonal effects in humans • Affects brain function
Tris(2,3-dibromopropyl) phosphate (TDBPP) *Known as brominated "Tris"*	Used in polyurethane foam; Banned from children's clothing in 1977		• Carcinogen
G. Non-halogenated organophosphate flame retardants			
Tri-ethyl-phosphate (TEP)	Also used for plasticizing, in anti-foam agents, and lacquers	• 1-10 million pounds produced per year	• Affects brain function • Lack of health studies
Tri-iso-butyl-phosphate (TIBP)	Also used for plasticizing, in anti-foam agents, and lacquers		• Lack of health studies
Tri-n-butyl-phosphate (TNBP)	Also used for plasticizing and as lubricants in hydraulic fluids	• 1-10 million pounds produced per year	• Carcinogen • Lack of health studies

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Chemical	How is it used?	How much is used in the US?[i] Is it Regulated?	Health Concerns[ii]
G. Non-halogenated organophosphate flame retardants (continued)			
Tri-(2-butoxyethyl)-phosphate (TBOEP)	Also used in floor wax, lacquers, and rubber stoppers	• 1-10 million pounds produced per year	• Affects brain function • Lack of health studies
Tri-(2-ethylhexyl)-phosphate (TEHP)	Used in clothing, also used for plasticizing and as a solvent	• Up to a half million pounds produced per year	• Carcinogen • Lack of health studies
Tri-cresyl phosphate (TMPP)	Used as flame retardant plasticizer, also as lubricant in hydraulic fluids	• 1-10 million pounds produced per year	• Can cause reproductive harm • Can cause developmental harm • Lack of health studies
H. Dechlorane plus flame retardant			
DP	Used in electronics	• 1-10 million pounds produced per year	• Chemically similar to organochlorine pesticides • Lack of health studies
I. Legacy Chemicals			
Polychlorinated biphenyls (PCBs) *Example: 2,2',3,4,4',5,5'-Heptachlorobiphenyl (CB 180)*	Used in transformers, capacitors, electrical equipment, floor finish, cable insulation, fluorescent light ballasts	• EPA banned production, sale, and use in 1979	• Evidence of impaired brain function in humans • Carcinogen • Affects hormone systems • Can cause reproductive harm
Polybrominated biphenyls (PBBs) *Example: 2,2',4,4',5,5'-Hexabromo biphenyl (BB 153)*	Historic flame retardant	• EPA banned production, sale and use in 1973	• Carcinogen • Affects hormone systems

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.

Chemical	How is it used?	How much is used in the US?[i] Is it Regulated?	Health Concerns[ii]
I. Legacy Chemicals (continued)			
Chlordane *Example: Trans-chlordane (TC)*	Pesticide	• EPA banned from food crops in 1978; banned from underground use in 1988, still manufactured for export	• Affects hormone systems • Affects brain function
Dichlorodiphenyltrichloroethane (DDT) *Example: 1,1,1,-trichloror-2,2-di(4-chlorophenyl)ethane (pp-DDT)*	Pesticide	• EPA banned in 1972; limited exceptions thereafter	• Carcinogen • Affects hormone systems

[i] Per 2006 EPA data
[ii] In animal studies unless otherwise noted

Dodson, R.E., L.J. Perovich, A. Covaci, N. Van den Eede, A.C. Ionas, A.C. Dirtu, J.G. Brody, R.A. Rudel. 2012. After the PBDE phase-out: A broad suite of flame retardants in repeat house dust samples from California. *Environmental Science & Technology*. In Press.