Why we need fire-safe furniture without flame retardants

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A California furniture flammability standard called Technical Bulletin 117 (TB117) has led to the use of toxic or untested flame retardant chemicals at high levels in furniture and baby product foam[1,2] across the USA and Canada since 1975.

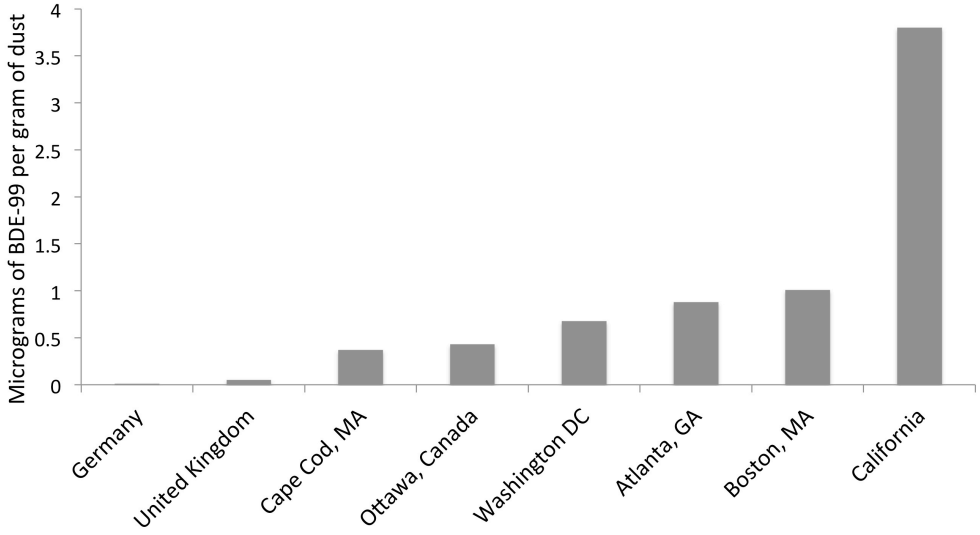
The major flame retardant chemicals used in foam to meet TB117 are associated with adverse health effects

- **PentaBDE** has been linked to decreased fertility[3], hormone disruption[4], lowered IQ[5,6] and hyperactivity[7] in humans. In animal studies, this chemical causes reproductive, thyroid, hormonal, developmental and neurological disorders[8]. It is one of 21 chemicals globally banned by the Stockholm Convention on Persistent Organic Pollutants, signed by 177 countries.
- **Chlorinated Tris or TDCPP** was voluntarily removed from children's sleepwear in the 1970s because it changed DNA[9]. It was listed as a carcinogen under California's Proposition 65 in 2011[10].
- **Firemaster 550** contains four flame retardant ingredients which are known to be toxic or lack adequate toxicity information[11–13]. Pilot studies links low level exposures to heart defects, obesity and anxiety in animals[14,15].
- Halogen-free replacements for banned flame retardants are also not proven safe. Some halogen-free alternatives show neurotoxicity and ecotoxicity while others have little information available[16].

Flame retardants move from products into the environment and into people, pets and wildlife

- Because of TB117, most U.S. furniture and baby products contain flame retardants in the foam and pounds of these chemicals can be found in homes and offices. They continuously migrate out of products into dust[17] (Figure 1)[18] and are ingested by humans[19] and pets[20,21].
- Californians have among the highest levels of pentaBDE measured in the world in their household dust and bodies[22] (Figure 1).

Figure 1. Concentrations of BDE-99, a pentaBDE component, in household dust[18]



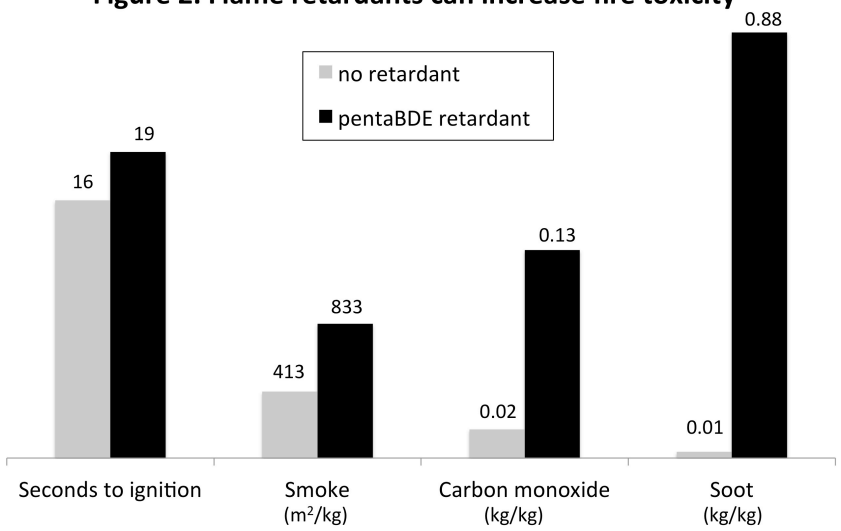
California has the highest level of BDE-99 in household dust measured in the world.

- Retardant chemicals cross the placenta and babies are born with the chemicals in their bodies[23]. Babies and toddlers are further exposed from their mother's milk and household dust, which they ingest at higher levels due to their hand-to-mouth behavior. Consequently, young children have three times the levels of retardant chemicals in their bodies compared to their mothers[24].
- The average lifetime of upholstered furniture is 30 years and lower income households have older furniture containing pentaBDE. Thus those with lower income, and especially children, have increasingly high levels of this toxic retardant chemical in their bodies compared to those in higher income households[25].
- Flame retardant chemicals are found in air, wastewater from homes, and landfill leachates[26–28]. The chemicals contaminate soil, rivers, the ocean, fish, marine mammals and the food supply[29]. "Fireproof killer whales" and other marine mammals along the California coast contain the highest reported levels in the world of pentaBDE in their body fluids[30].

Flame retardants as used to meet TB117 do not provide a fire safety benefit

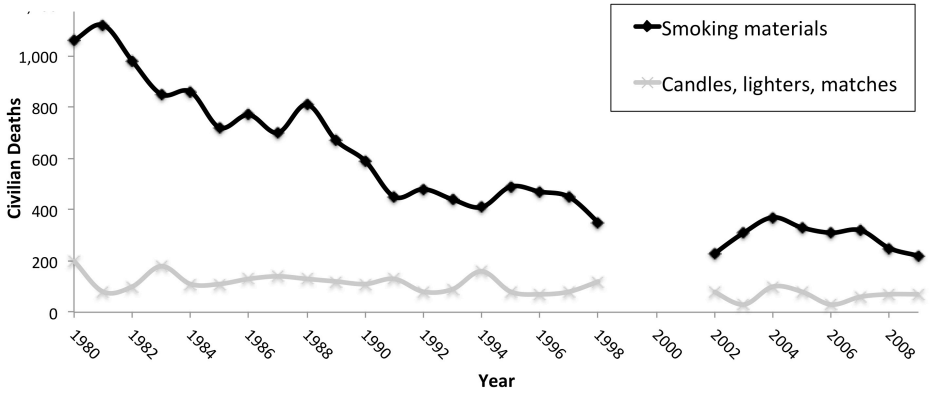
- TB117 requires the foam inside furniture to withstand a 12-second exposure to a small open flame. However in a real-life fire, fabric ignites first, exposing the interior foam to a much larger flame[31]. When this happens, flame retardants in foam do not prevent ignition of the foam or reduce the severity of the fire[32–34].
- Foam containing flame retardants as used to meet TB117 can make the cover fabric more likely to burn from smoldering sources like cigarettes[35].
- When foam containing flame retardants burns, it can give off higher levels of carbon monoxide, soot, and smoke compared to untreated foam (Figure 2)[36]. The majority of residential fire deaths result from inhalation of toxic gases, soot and smoke[37].
- When pentaBDE, Firemaster 550 and other related retardant chemicals burn, they produce high levels of dioxins and furans, compounds that are known to cause cancer. Firefighters have elevated rates of cancers that are associated with exposure to dioxins/ furans[38].
- Upholstered furniture fires started by smoking materials, the leading cause of furniture fire deaths, have fallen sharply since 1980. No change was seen for upholstered furniture fire deaths started by small open flames (candles, lighters, matches), the type of fires that should have been addressed by TB117 (Figure 3)[39].

Figure 2. Flame retardants can increase fire toxicity[36]



When foam alone is tested, pentaBDE provides a 3 second delay in ignition compared to foam with no retardant. However, upon burning, pentaBDE foam produces 2 times as much smoke, 7 times as much carbon monoxide, and 70 times as much soot. Y axis for each category is a different scale.

Figure 3. Civilian deaths from home upholstered furniture fires, 1980-2009[39]



TB117 should address fires started by small open flames, such as candles, lighters and matches. However, there has been no change in the number of deaths caused by this type of fire. In contrast, the number of deaths from fires started by smoking materials has decreased dramatically.

- Since 2007, there have been four bills introduced to change TB117 through the California legislature. The flame retardant industry spent a documented 23.2 million dollars on lobbying to defeat these bills[40].
- Since most furniture fires are caused by cigarettes and begin in fabric, the California Bureau of Electronic and Appliance Repair, Home Furnishing and Thermal Insulation proposed to change the current TB117 open-flame test to a smolder standard for fabric (TB 117-2013). This would improve fire safety without the need for toxic retardant chemicals. The CPSC published a similar draft standard in 2008 and predicted:
    - The vast majority (85%) of upholstered furniture currently on the market would already be in compliance because existing cover fabrics meet the proposed requirements without added chemicals.
    - The remaining upholstered furniture would likely be redesigned with the use of smolder proof fabrics, batting (10%) or barriers (5%).

GLOSSARY:

Flame retardant (FR)
A chemical added to a material (e.g., foam or plastic) to change its flammability properties and reduce its ability to ignite and/or burn. Flame retardant chemicals are usually used to meet the requirements of a mandated flammability test (e.g., must withstand a 12 second exposure to a small open flame to meet the California furniture flammability standard TB117).

Halogenated FRs
Chemicals used for flame retardant purposes containing halogen atoms (typically either bromine or chlorine) substituting for hydrogen in an organic molecule.
Brominated FRs; FR chemicals involving partial or full substitution of hydrogen by bromine in an organic molecule.
Chlorinated FRs: FR chemicals involving partial or full substitution of hydrogen by chlorine in an organic molecule.

Polybrominated diphenyl ethers (PBDEs)
Structurally similar to the carcinogenic compounds dioxins and furans, PBDEs are compounds with one to ten bromine atoms arranged around two benzene rings joined by an oxygen atom.

Three commercial mixtures (i.e., pentaBDE, octaBDE, and decaBDE, named after the average number of bromine atoms attached were among the most commonly used FR:
PentaBDE: contains PBDE molecules with four, five, and six bromine atoms per molecule; was used primarily in furniture foam, carpet padding, and vehicles in North America. It has been linked to decreased fertility, hormone disruption, lowered IQ and hyperactivity
OctaBDE: contains PBDE molecules with six to ten bromine atoms; used primarily in manufactured plastic products – in particular acrylonitrile-butadiene-styrene (ABS) polymers in computer casings and monitors.
DecaBDE: composed mostly of *BDE-209* with ten bromine atoms; used primarily in hard plastic, fabric back-coating, and electronics.

When burned, PBDEs can produce highly toxic brominated dioxin and furan compounds. Due to their toxicity and persistence, pentaBDE and octaBDE are no longer manufactured in the U.S. or the European Union (EU). DecaBDE will be voluntarily phased out in the U.S. by 2013. PentaBDE and octaBDE commercial mixtures are also among a short list of chemicals targeted globally to be eliminated from production and use by the Stockholm Convention on Persistent Organic Pollutants.

Halogenated organophosphate FRs
A number of halogenated organophosphate flame retardants, often referred to simply as Tris, have been used in a wide range of consumer products. Below are the most popular ones, their uses, and what is known about their health effects.
TDBPP (or TDBP), Brominated Tris, tris(2,3-dibromopropyl)phosphate. TDBPP was removed from children's sleepwear in the 1970s due to its mutagenicity and likely carcinogenicity. It is listed as a carcinogen under California's Proposition 65.
TDCPP (or TDCP), Chlorinated Tris, tris(1,3-dichloro-2-propyl)phosphate: Commonly used in furniture, carpet, and transportation foams as well as in baby products. TDCPP was voluntarily removed from children's sleepwear in the 1970s. It is listed as a carcinogen under California's Proposition 65; according to conclusions form a 2008 EU risk assessment it meets the criteria for persistence.
TCEP, tris(2-chloroethyl)phosphate: Has been used in rigid foam, but its use has declined significantly since being listed as a carcinogen in the European Union and under California's Proposition 65. In 2011, it was also banned from use in children's products in New York.
TCPP, tris(1-chloro-2-propyl)phosphate: Used in blown-in insulation and in foam. It has unknown health effects.

Dioxins and furans
Very toxic compounds produced inadvertently, such as through incomplete combustion of wood, fossil fuels and other organic chemicals. When halogens are present (e.g., chlorinated or brominated FRs), highly toxic and persistent compounds can be produced, such as polychlorinated dibenzo-p-dioxins and polybrominated dibenzo-p-dioxins.

ADDITIONAL RESOURCES:

Playing with Fire (*Chicago Tribune* special on flame retardants) http://media.apps.chicagotribune.com/flames/index.html
Are You Safe on that Sofa? (*The New York Times Op-Ed*)
http://www.nytimes.com/2012/05/20/opinion/sunday/kristof-are-you-safe-on-that-sofa.html?_r=2&ref=opinion
Chemical Burns (*The New York Times Op-Ed*) http://www.nytimes.com/2006/11/19/opinion/19blum.html
San Antonio Statement on Brominated and Chlorinated Flame Retardants signed by 220 scientists
Published in *Environmental Health Perspectives* http://ehp03.niehs.nih.gov/article/info:doi/10.1289/ehp.1003089
Identification of Flame Retardants in Polyurethane Foam Collected from Baby Products
Published in *Environmental Science & Technology* http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3113369/?tool=pubmed
TEDx video presentation: 15 minute overview of the flame retardant problem http://www.youtube.com/watch?v=6IDlb4N-_u4
CITRIS Seminar: 45 minute presentation on risks and benefits associated with flame retardants
http://www.youtube.com/watch?v=A5njba_nhgc

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