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FLAME RETARDANTS IN FURNITURE AND BUILDING INSULATION FOAMS: POLICIES AND IMPLICATIONS IN NORTH AMERICA

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Introduction

Flammability standards and regulations for furniture, foam plastic building insulation, and other products were established starting in the 1960s and 1970s in an attempt to address burning hazards of plastics, which were becoming much more widely used. A variety of organohalogen and organophosphate flame retardant chemicals (FRs) have been adopted as a cost-effective means of complying with these standards and regulations.[1,2] Recently, the use of FRs in furniture and in foam plastic building insulation has been questioned based on:

1. Scientific studies associating some FRs with adverse health effects[3-15]
2. Research finding a lack of demonstrated fire safety benefit from flame retardants as used in certain categories of products[4,5]

Recent experience shows that updated flammability standards could reduce the use of FRs in the U.S. and Canada while maintaining fire safety.

This paper will discuss flammability standards and regulations governing upholstered furniture and foam plastic insulation, the FRs used to achieve compliance, and recent policy changes and opportunities for improved standards and regulation. Potential impacts of policy changes on flame retardant usage and fire safety will also be explored.

Materials and methods

We conducted a review of literature pertaining to fire behavior of, FRs in, and standards and regulations for upholstered furniture and foam plastic building insulation. We also reviewed published standards and regulations governing flammability of those materials. Interviews with government representatives, subject experts, and stakeholders, as well as in-person attendance and participation at public meetings, further informed this analysis.

Results and discussion

Upholstered Furniture: The California residential furniture flammability standard Technical Bulletin 117 (TB117), issued in 1975, required foam inside upholstered furniture to withstand a small open flame for twelve seconds.[16] For some filling materials, including polyurethane foams, this test was typically met by adding FRs to the foam filling. Due to the size of the California market, liability concerns, and a desire to eliminate dual inventory, TB117-compliant furniture eventually became common across the U.S. and Canada.[2]

FRs used in polyurethane furniture foam include pentabromodiphenyl ether (PentaBDE), tris(1,3-dichloroisopropyl) phosphate (TDCPP), Firemaster 550, and non-halogenated phosphate flame retardants, with a greater variety of FRs used since the 2005 phase-out of PentaBDE.[2] Numerous studies have linked the older FRs with adverse health and environmental outcomes, including persistence, endocrine disruption, cancer, and reproductive, neurological, and immune impairments.[3,5-15] Many of the FRs used after 2005 do not have adequate health data, but molecular structure similarities to previous generations of FRs, bolstered by recent studies, suggest that some of these may also show similar harmful properties.

Following decades of FR use in foam furniture fillings to meet TB 117-1975, regulations in California were updated to maintain fire safety and facilitate reduced use of FRs.[17] The new required standard, called Technical Bulletin 117-2013 (TB117-2013), is a smolder test for assemblies of fabric, foam, optional interliner, and decking materials. The smoldering source is applied to the cover fabric, where fires start, rather than to the foam filling.[18] TB117-2013 became mandatory for all new furniture manufactured for sale in California beginning January 1, 2015. A new California law also requires that furniture include a label stating whether it contains or does not contain FRs.[19] TB117-2013 is expected to maintain or moderately improve fire safety, and the furniture industry estimates that the majority of residential furniture manufactured in the U.S. is now made without FRs in the foam. This has been recognized as a major victory for public and environmental health and can provide a model for flammability standards for other products.

In spite of this progress, voluntary standards organizations (VSOs) including the National Fire Protection Association (NFPA) and UL Canada continue to work towards new flammability requirements for furniture:

• NFPA initiated development of a new standard, NFPA 277, in 2014 based on unsubstantiated claims that TB 117-2013 fails to provide necessary protections against open flame ignition sources.
• UL Canada is in the process of drafting a new flammability standard for furniture in public spaces. The scope of and need for this new standard have not yet been publicly released.

The committees responsible for fire safety strategies at VSOs typically do not include public health or environmental expertise or significant representation of labor or consumer interest groups. Decisions have historically been made without a cost-benefit analysis that could evaluate potential adverse health and ecological outcomes associated with FRs used to meet a proposed standard. These new initiatives are calling for open-flame standards, which are often met through the use of added FRs and which may not improve performance of furniture in realistic fire scenarios. If new open-flame furniture standards are developed, furniture manufacturers may return to use of FRs in order to achieve compliance.

Foam Plastic Building Insulation: Foam plastic building insulation, primarily extruded and expanded polystyrene (XPS and EPS), polyurethane, and polyisocyanurate materials, are affordable, efficient, and widely used in buildings throughout the U.S. and Canada. These materials are used in a variety of applications, including for under-slab and foundation or basement walls; wall cavities; attics and ceilings; and continuous exterior insulation.

State, provincial, and local building codes in the U.S. and Canada are based on model codes published by the International Code Council (ICC), including the International Building Code (IBC) and the International Residential Code (IRC). In general, these codes require that foam plastic insulation meet performance requirements of the fire test ASTM E84 regardless of where it is installed in a finished building; and that the insulation is protected by a code-compliant thermal barrier such as 0.5-inch thick gypsum wallboard, or equivalent.[20] Depending on the specific use, insulation may be subject to additional installation or flammability requirements. ASTM E84 was not developed for use on foamed plastics and its application to those materials has been questioned.[4]

ASTM E84 requirements are currently met by adding halogenated FRs to foams. For decades, polystyrene insulations have contained hexabromocyclododecane (HBCDD) at levels of about 0.7% for expanded polystyrene (EPS) and 2.5% for extruded polystyrene (XPS).[21,22] Polyurethane and polyisocyanurate insulations contain tris(1-chloro-2-propyl) phosphate (TCPP) at levels of 2 – 25%, depending on the use.[23] Use of these FRs in insulation may result in occupational exposures during FR and insulation manufacturing, installation of insulation, building demolition, and the waste management stage, in addition to exposing building occupants.[24] The U.S. National Institute for Occupational Safety and Health (NIOSH) is currently conducting a study of FR exposures to appliers of spray polyurethane foam insulation.[25]

In 2013, HBCDD was listed as a persistent organic pollutant under the Stockholm Convention.[26] Countries that have ratified the Stockholm Convention have or are now determining appropriate management plans. Countries have until 2017 to stop use of HBCDD, and in the meantime insulation containing HBCDD must be labeled as such. HBCDD use in the U.S. is similarly expected to decline though there is no mandatory deadline for phase-out.[27] The major replacement for HBCDD in polystyrene insulation is a brominated styrene butadiene copolymer, synthesized by Dow Chemical Company and referred to as, “PolyFR.” Dow has licensed production of this compound to Chemtura, Albemarle, and ICL, where it is manufactured under the trade names Emerald Innovation™ 3000, GreenCrest™, and FR-122P, respectively.

The US EPA Design for the Environment program identified this copolymer as a preferable substitute for HBCDD in polystyrene insulation.[28] While marketed as “non-PBT” (Persistent, Bioaccumulative, and Toxic), PolyFR is expected to be highly persistent. Evaluations have been limited to high molecular weight formulations only; environmental breakdown products have not yet been studied, and low molecular weight formulations or impurities may be PBT. Furthermore, PolyFR is still expected to lead to the formation of halogenated dioxins and furans in fires or during thermal processing.[29,30] Questions remain about the life cycle of PolyFR, including possible occupational exposures to chemical and insulation manufacturing workers and insulation installers, and potential environmental impacts from degradation products.

Opportunities for Reducing Hazard from FRs in Building Insulation

1. Updating Flammability Requirements.

Studies have shown that compliance with the ASTM E84 requirements does not significantly improve fire performance of insulation within a wall cavity; compliant insulation has also been shown to perform poorly in fire tests of exposed or bare foam.[31-33] Buildings or building assemblies that contain insulation with FRs have not been shown to have superior fire performance relative to those that contain insulation without FRs. As such, ASTM E84 requirements for insulation foams do not contribute to building fire safety.[4] Similar to the example of California’s furniture regulations, opportunities exist to update flammability requirements for insulation to maintain fire safety and facilitate reduced use of FRs.

Building code requirements in Sweden and Norway focus on fire resistance of the building assembly (including, e.g. wallboard or masonry) rather than on fire performance of bare insulation. Foam plastic building insulations in these countries consequently do not contain FRs.[34] There is no data to suggest that fire losses in Sweden and Norway have increased due to this factor. Further research is needed to evaluate the impact on FR levels in homes and the environment since insulation without FRs has become the norm in Scandinavia.

Updates to flammability requirements at the state, provincial, or local levels could serve as a catalyst for similar changes in other building codes or in the IRC or IBC, which are on a three-year revision cycle. Proposals were made to the 2015 IRC and to the 2018 IRC and IBC to exempt certain uses of foam plastic insulation from ASTM E84 testing. These proposals have so far been unsuccessful, though they have received support from some of the fire safety and code community.[35] Such efforts are expected to continue; and further support is needed from the scientific and building communities.

Foam plastic insulation is one of the leading uses of FRs, accounting in 2008 for approximately 80% of TCPP use and 90% of HBCD use.[22-24] Production of the polymeric replacement for HBCDD exceeded 25,000 MT at the end of 2014.[36] As energy efficiency becomes a priority in mitigating climate change, the use of foam plastic insulation is expected to increase. If flammability requirements for certain applications of foam plastic building insulation were updated, the use of FRs could be reduced significantly.

2. Use of Alternative Insulation Materials

While foam plastic building insulation is widely used throughout the U.S. and Canada, it is not the only option for achieving energy-efficient buildings. In some cases, alternative insulation materials with preferable toxicological or environmental profiles can be used, for instance natural wool, cellular glass, cork, or cementitious foam. These materials can be more costly than foam plastic insulation materials; but with greater adoption, costs may decrease. In additional to cost, one barrier to use of these alternatives may be a lack of easily-accessible information about how and where to install and use alternatives. Greater adoption of alternative materials may strengthen incentives for manufacturers to improve health and ecological profiles of foam plastic insulation.

Conclusions and Recommendations
Policy decisions pertaining to the flammability of upholstered furniture and foam plastic insulation materials should consider the possible health and environmental impacts of FRs as well as the need for fire safety in regards to furnishings and buildings. Increased awareness of potential health concerns and a lack of proven fire safety benefit from FRs used in these products have shifted thinking among some decision makers about appropriate flammability requirements. California furniture regulations may provide a model for other products where fire safety can be maintained while reducing use of FRs.

Updated flammability standards may provide better reproducibility and correlation to real-life fire scenarios. Further study is needed to determine the extent to which fire safety and flame retardant use may be impacted by the new TB117-2013 or possible changes to the U.S. building codes. Further study is also needed to improve understanding of health and environmental impacts of alternative FRs, including the HBCDD replacement PolyFR and its breakdown products, and to quantify emissions of FRs throughout product life cycles.

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