



**Chemical  
Insights**

An Institute of  
Underwriters Laboratories Inc.



# **Specifying Residential Upholstered Furniture to Safeguard Human Health and Well-Being: A Toolkit for Reducing Fire and Chemical Risks**

2021



# Table of Contents

<b>Toolkit Overview</b>	<b>4</b>
<b>About This Toolkit</b>	<b>5</b>
<b>The Role of the Interior Designer</b>	<b>5</b>
<b>The Role of Upholstered Furniture in Residential Fires</b>	<b>6</b>
<b>Residential Fire Statistics</b>	<b>7</b>
<b>Flame Retardants and Their Impact on Health</b>	<b>8</b>
<b>Flame Retardant Use in Upholstered Furniture</b>	<b>9</b>
<b>Performing a Risk Assessment</b>	<b>10</b>
<b>Resources for Identifying Chemical Flame Retardant Health Effects and Risks</b>	<b>10</b>
<b>Programs for Identifying Hazard Information on Chemical Composition of Materials</b>	<b>11</b>
<b>Timeline of Events and Regulations Related to the Chemical and Fire Safety of Residential Upholstered Furniture</b>	<b>12</b>
<b>Understanding Flammability Standards</b>	<b>13</b>
<b>Considering Fabrication Strategies for Slowing Ignition: A Decision Tree</b>	<b>14</b>
<b>The Research: Assessing Chemical Exposure and Fire Performance</b>	<b>15</b>
<b>Summary of Findings</b>	<b>16</b>
<b>What is a Fire Barrier?</b>	<b>17</b>
<b>Specifying a Fire Barrier</b>	<b>19</b>
<b>Connect with the Client</b>	<b>19</b>
<b>Get Informed</b>	<b>20</b>
<b>Advocate for Chemical Safety and Fire Safety</b>	<b>21</b>

## Notes on Sources

Unless stated otherwise, statistics and technical content referenced throughout this toolkit comes from *Underwriters Laboratories Inc. Guidance Document 118F: Managing Fire and Chemical Exposure Risks of Residential Upholstered Furniture*. For those who wish to check a fact or do further reading, please see this guidance document. Links to technical bulletins and briefs are also provided throughout this toolkit for further information and sources on the following topics: *Residential Fire Statistics*, *Flame Retardant Exposure* and *Fire Regulations and Flame Retardant Usage Trends*.

If information does not come directly from the *UL Guidance Document 118F*, the statement will begin with the name of the organization that provided the research (for example, "According to the *National Institute for Occupational Safety and Health (NIOSH)*, newer homes can burn faster due to open floor plans and a more complex mixture of materials and finishes.").



## Toolkit Overview

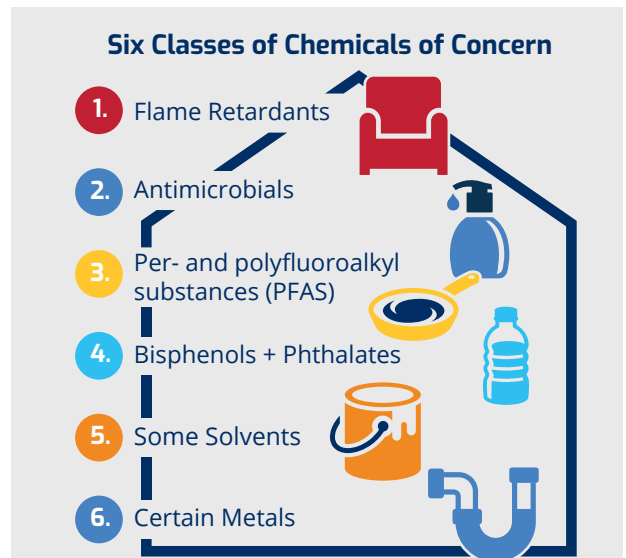
Residential upholstered furniture is a significant financial investment for any homeowner with an estimated 10% – 50% of the cost of a home spent on furniture. More importantly — beyond style, durability and cost — is the consideration of its human health impacts. There is a growing awareness of upholstered furniture’s potential role in introducing chemicals of concern into the indoor environment. With upholstered furniture’s life expectancy of 20+ years, not only does the expertise of the interior designer provide an opportunity to address human health and well-being; it requires it. But to do so holistically also necessitates considering fire safety as key to a safe and healthy home.

Fires are a known hazard that most people assume will never impact them directly. In the U.S., however, residential fires account for the vast majority of fire-related civilian casualties (77%) and financial losses. Most people also do not realize that their upholstered furniture, if not designed with fire safety in mind, has the potential to act as a fuel source during a fire. Today, one out of 12 reported residential upholstered furniture fires results in death. But to complicate things, flame retardants (which are commonly added to polyurethane foam or cover fabrics to increase fire ignition resistance) pose potential health risks associated with both daily exposure and fire exposure.

Protection from fire hazards and chemical risks are not mutually exclusive and should be an essential safety feature of residential furniture. New research has evaluated the chemical exposure risks of residential upholstered furniture alongside its fire safety risks, looking at various flame-resistant fabrication strategies. This research found that there is a way to manufacture chairs without the use of chemical flame retardants that successfully addresses fire safety concerns. Specifically, this can be achieved through use of a **fire barrier** that fully encapsulates the cushion in upholstered furniture.

### This toolkit:

- **Presents a case for why both chemical safety and fire safety must be considered when selecting furniture.**
- **Offers guidance on how to specify solutions that address this safety convergence, and**
- **Summarizes meaningful research on flame retardant exposure and furniture flammability.**



There is an abundance of research and information available to designers that addresses mitigating the impacts of consumer products and building materials on indoor air quality. They often focus on six specific classes of chemicals of concern. These chemicals can be released into the air and dust for human exposure contributing to health concerns, especially for vulnerable populations. This toolkit focuses specifically on flame retardants and safer chemical approaches to mitigating fire risks.

Source: SixClasses.org



## About This Toolkit

In 2013, Chemical Insights of Underwriters Laboratories Inc. began a *Furniture Flammability and Human Health (FFHH)* initiative involving multiple stakeholder gatherings and on-going research to explore the fire safety and chemical safety of residential upholstered furniture. In the spring of 2020, Chemical insights delivered a [webinar](#) to the furniture industry on their groundbreaking research hosted by the Sustainable Furnishings Council. After the success of the webinar, a national *FFHH Taskforce* was convened to explore this issue in greater detail. This expert volunteer group consisted of public health advocates, environmentalists, designers, fire experts, chemical and furniture material suppliers, and chemical exposure experts. The *FFHH Taskforce* was instrumental in compiling scientific resources and summarizing key facts and action steps that were ultimately compiled in [UL Inc. Guidance Document 118F: Managing Fire and Chemical Exposure Risks of Residential Upholstered Furniture](#).

This toolkit presents the technical content within this guidance document and summarizes it into an education tool for interior designers. While the research and guidelines presented in this toolkit focus on residential upholstered furniture, the resources and information may also be applicable to other environments where upholstered furniture is used, such as healthcare, office reception areas and school lounges.

**DISCLAIMER:** While there are additional product attributes to consider in furniture design beyond fire hazards and chemical risks protection, this toolkit focuses specifically on processes for optimizing fire and chemical flame retardant safety.

Additionally, this toolkit is a working document. As technologies evolve and new research emerges on this subject, this document will be updated to reflect new insights on this topic.



## The Role of the Interior Designer

Greater knowledge of fire safety considerations, including fabrication strategies for slowing ignition, flammability standards and potential chemical exposure issues will provide you with the expertise to specify upholstered furniture solutions that better address your clients' health and safety goals. Interior designers play a key role in communicating about the fire barrier technology and the opportunity that it presents — the ability to achieve both fire and chemical safety features without sacrificing one over the other. This toolkit will help you:

- **Connect** with your clients to bring fire safety into the health and wellness conversation and consider which fabrication strategies best fit their needs and concerns,
- **Educate** yourself and others about how to specify a fire barrier, and
- **Advocate** for solutions that minimize both fire hazards and chemical exposure risks, and ultimately lead to a closed-loop system.



## The Role of Upholstered Furniture in Residential Fires

U.S. fire departments respond to an average of 353,100 home structure fires per year, which cause approximately 2,620 civilian deaths, 11,030 civilian fire injuries and \$7.2 billion in direct property damage. While the U.S. has been successful in reducing the total number of fires over the past few decades, the issue of preventing a death once a home fire is reported has not been solved. The death rate from fires grew 15% between 1980 and 2019, rising from 7.1 to 8.2 fatalities per 1,000 home fires. And, both the National Fire Protection Association (NFPA) and the American Red Cross report that, today, people have just one to two minutes to escape a home once a fire alarm sounds.

It will come as no surprise that most fires occur in the kitchen, but it may be surprising to learn *where* most **fire deaths** occur. Most home fire deaths (49%) are caused by fires in living rooms and bedrooms — where upholstered furniture can be found. The average death rate in these rooms has more than doubled over the last 40 years and living room fires are more likely to cause death than fires in any other area of the home. Residential living room studies report that “flashover” (fire spread resulting in full room involvement) typically occurs in less than five minutes.

**Current statistics report that of fires that result in death, residential upholstered furniture is the leading item to ignite, above mattresses and flammable liquids. When residential upholstered furniture was the first item to catch on fire, it resulted in 17% of home fire deaths. This suggests that efforts to mitigate residential fire risks associated with upholstered furniture over the past few decades have not been overly successful.**

Today, according to the National Institute for Occupational Safety and Health (NIOSH), newer homes can burn faster due to open floor plans and a more complex mixture of materials and finishes. Synthetic materials are found throughout most modern homes in everything from toys to furniture and appliances. During a fire, these materials can burn hotter and faster, and can produce more toxic smoke than natural materials. When materials burn, they produce lethal gases, for example, hydrogen cyanide. Most people who die in a fire die from smoke inhalation, not burns. The Federal Insurance and Mitigation Administration (FIMA) warns that after a fire, the interior can include particulates, exposed asbestos, lead-containing building materials (such as glass and lead paint) and chemical residues. Upholstered furniture is the second leading factor enhancing smoke development in fatal residential fires.

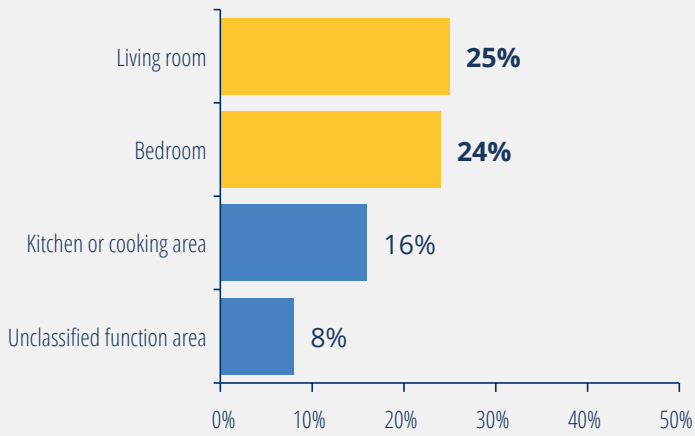
For more information, see the [Chemical Insights Technical Bulletin: Residential Fire Statistics](#).



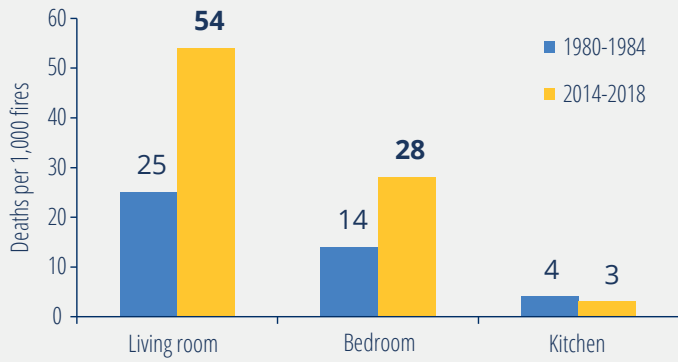
**1** out of **12** reported residential **upholstered furniture fires** results in **death**.



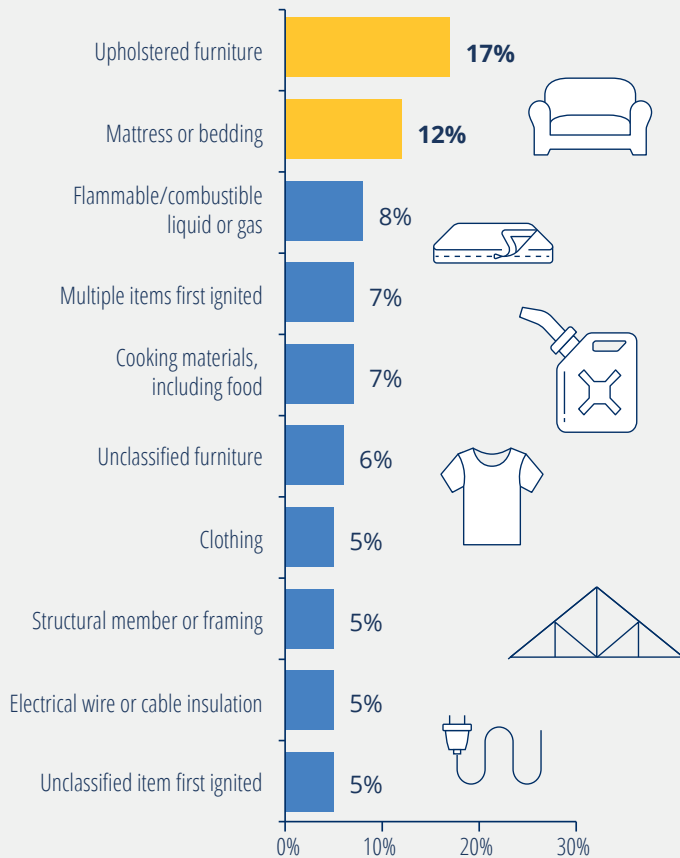
## Where do most fire deaths occur?



## How does this compare to 40 years ago?



## What is the first item to catch fire?



## How quickly can a flashover occur?



# HEALTH CONCERNS

associated with residential upholstered furniture arise from both

# DAILY USE & FIRE



## Flame Retardants and Their Impact on Health

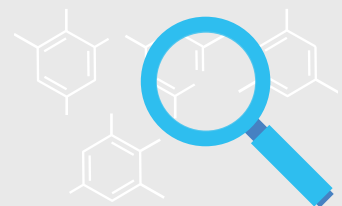
Specific flame retardants used in residential upholstered furniture have been identified as known health hazards; we are exposed to them during daily use, and our bodies metabolize them increasing human health risk. Flame retardants are semi-volatile, which means that they can migrate into surrounding air and dust in a typical indoor environment. Studies have shown that this results in human exposure via inhalation (breathing), ingestion (hand-to-mouth contact) and/or dermal transfer (surface-to-skin contact). Studies have also shown that exposure levels are elevated during a fire and that fire fighters show higher rates of certain types of cancer than the general U.S. population.

Flame retardants can be persistent, bioaccumulative, toxic chemicals (PBTs), which means they can persist in the environment and bioaccumulate in people and wildlife. In fact, recent studies have detected certain flame retardants in placental tissues, suggesting they may be transferred to the developing infant. Many flame retardants used in residential upholstered furniture have been found to be carcinogenic or associated with adverse human developmental effects like thyroid disruption, delayed mental and physical development, obesity, advanced puberty, reduced fertility and decreased lung function.

**As we continue to better understand the impact of flame retardants on human health, the need to reduce human exposure becomes clearer.**

## Check It Out...

Duke University offers a foam screening program to U.S. consumers who would like to know if flame retardants are in their residential upholstered furniture and other children's products. Consumers can submit foam samples voluntarily and free of charge to the [Duke University Foam Project](#) for analysis and obtain the results. Recent data shows that flame retardants have been found in approximately 50% of the samples.



For more information on flame retardants, see: [Chemical Insights Technical Bulletin: Organic Flame Retardant Exposure](#).

# Flame Retardant Use in Upholstered Furniture

Furniture manufacturers can add flame retardants to any chair components made of polymer materials, such as cover fabric, decking fabric and padding or filling. They are commonly added to polyurethane foam because it can act as a fuel source during a fire. Most flame retardants detected in upholstered furniture can be classified into two application types: **additive** and **reactive**.

- **Additive flame retardants** are mixed with or coated on materials to slow the rate of flame spread. They can be small molecules, which can easily migrate out of the materials or larger molecules (polymeric additives), which are less likely to migrate. Common flame retardants can be classified as **organohalogens**, which have compound structures that are similar to thyroid hormones, and **organophosphates**.
- **Reactive flame retardants** are chemically bound to polymer chains in polyurethane foam during the manufacturing process. These flame retardants are “built-in” and cannot easily migrate. Product manufacturers often refer to these as “green” flame retardants or refer to materials containing reactive flame retardants as “inherently flame retardant.”

**Select Flame Retardants Commonly Found in Foam**

Type	Examples	History of Use in Foam	Possible Health Effect
<b>Additive organohalogens</b>	PentaBDE (Pentabromodiphenyl Ether)	Applied to foam. Once the most widely used but phased out due to their toxicity and persistence. Not produced since 2004 but still found in existing furniture.	Persistent, Bioaccumulative Carcinogenic Endocrine disruption Obesity
	TDCPP (Tris (1,3-dichloro-2-propyl) phosphate)	Most common flame retardant identified in foam by the Duke University Foam Project. Added to California Prop 65 List in 2014, use is decreasing. Still used in transportation foam and building insulation.	Delayed development Endocrine disruption Reproductive outcomes
	Commercial mixtures of TBB, TBPH, TPhP and iTPP, such as Firemaster 550® and Firemaster 600®	Widely used in foam. Gained market share with pentaBDE phase out.	
	TCPP (tris (1-chloro-2-propyl) phosphate)	Used in foam.	
	2-ethylhexyl 2, 3, 4, 5-tetrabromobenzoate (TBB), bis(2-ethylhexyl)-2,3,4,5-tetrabromophthalate (TBPH)	Used in foam.	
<b>Additive organophosphates (OPFRs)</b>	Triphenyl phosphate (TPhP) TPhP analogs with various degrees of aryl isopropylation (iTPHPs)	Used in foam. Use has increased in recent years due to phase out of other halogenated flame retardant formulations.	Neurodevelopment Endocrine disruption Reproductive outcomes Respiratory outcomes and allergic diseases Persistent (soluble and can persist in water)
<b>Reactive chemistries</b>	Polymer reactive, such as Exolit® OP 560	Used in foam. Gaining popularity.	Identification via current analytical screening processes cannot detect reactive flame retardants because of their proprietary status (chemical composition is unknown).

**As more evidence on the health impacts of one class of flame retardant is found, the demand for another class of flame retardants arises.**



# Performing a Risk Assessment

While the furniture industry in the U.S. is generally moving further away from the use of flame retardants in upholstered furniture, they are still widely used in a variety of building products and materials, and may even be required in specific furniture applications. As an interior designer with chemical safety and fire safety expertise, it is important to be aware, be knowledgeable and help guide your client through a decision-making process that ultimately puts their health, safety and welfare at the forefront. This is where managing the risks of flame retardants gets complicated and a **risk assessment** is required if they are used.

Health risk is characterized by dose and exposure assessments of a hazardous substance. Many chemical flame retardants have been identified as hazardous and available dose and exposure studies have indicated human health risks associated with them. This, in return, presents opportunities for risk management in the design, construction and use of residential upholstered furniture.

## To quantify health risks, you must answer:

### *What hazard does this substance present and who is harmed?*



**Hazard:** A source of potential adverse health outcome. A hazardous material must have an exposure and a dose to cause an effect and thus risk.

### *What type of exposure causes harm?*



**Exposure:** Contact of a substance with a boundary of the body — an epithelial layer. Exposure can come through three routes: inhalation, ingestion or dermal contact. Exposure may be short-term (acute exposure), of intermediate duration (semi-chronic) or long-term (chronic exposure). Exposure level to a substance of concern can also vary over the life of the material. Some materials may be more harmful during construction or disposal. For example, insulation and electrical wiring with flame retardants that are encapsulated in the wall may pose more potential risk to the installer and less to a building occupant.

### *How much of the substance is considered a safe “dose”?*



**Dose:** The amount of a substance that passes through an epithelial layer and thus enters the body. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people are exposed by eating, inhaling and/or absorbing through the skin. In general, the greater the dose, the greater the likelihood of an effect.

### *What is the risk?*



**Risk:** The probability or chance of harmful effects to human or ecological health resulting from exposure and subsequent dose to a stressor, including any physical, chemical or biological entity that can induce an adverse response.

The answers to these questions are not always easy and straightforward. There is a lot of data to collect and consider for every chemical in a product and in many applications. Therefore, within the furniture industry, risk assessment often relies on either **hazard avoidance** and/or the **use of certifications and chemical disclosure tools that identify chemical hazards and quantify the risk.**

## Resources for identifying chemical flame retardant health effects and risks:

- [California Office of Environmental Health Hazard Assessment \(OEHHA\): Proposition 65](#)
- [Centers for Disease Control and Prevention \(CDC\): Agency for Toxic Substances and Disease Registry \(ATSDR\)](#)
- [U.S. Department of Health and Human Services: National Toxicology Program \(NTP\)](#)
- [U.S. Environmental Protection Agency \(EPA\): Integrated Risk Information System \(IRIS\)](#)

The National Institute of Environmental Health Sciences (NIEHS) reports that there are hundreds of flame retardant chemicals. However, only a selection of flame retardants have been studied and identified in these resources. As more data becomes available these lists are updated.

The programs identified below provide valuable hazard information on chemical compositions of materials and include specific data on the acceptability of chemicals for use, including flame retardants, other coatings and finishes used in upholstered furniture fabrication.

Program	Description	Type of Standard or Certification	Products Covered
Cradle to Cradle	A globally recognized measure of safer, more sustainable products made for the circular economy	Third-party certification, Multi-attribute certification	Wide range of sectors
Declare	Disclosure tool from the Living Building Challenge (LBC) that presents information about product ingredients in an easy-to-understand format	Third-party certification option, Multi-attribute certification	Ingredients to avoid (scanned against the LBC Red List)
GreenScreen® For Safer Chemicals	An open, transparent and publicly accessible method for chemical hazard assessment	Third-party disclosure tool, Multi-attribute, Scores chemicals based on information from over 40 hazard lists	Wide range of sectors, including building, electronics and textiles
Health Product Declaration Collaborative (HPD)	A standard specification for accurate, reliable and consistent reporting of product contents and associated health information	Standard specification reporting tool, Multi-attribute	Products in the built environment
LEVEL (BIFMA) Certification	A certification for office furniture and furnishings products based on the ANSI/BIFMA e3 Furniture Sustainability Standard	Third-party certification, Multi-attribute	Office furniture and furnishings
mindful MATERIALS (mM)	A platform aggregating human health and environmental impact product data from leading manufacturers, vetted by experts and easily accessible	Material Library brings together third-party certifications and information from across the industry	Products in the built environment
Perkins + Will Transparency	A precautionary list that compiles chemicals of concern to screen toxic chemicals during product selections	Searchable list of chemicals of concern, Single-attribute	Products in the built environment
Sustainable Furnishings Council's "What's it made of?" Initiative	An initiative focused on improving supply chains to remove chemicals with known health concerns, including flame retardants	Standard practices recommended for designers  List of five chemicals to avoid in home furnishings and a supply chain questionnaire for designers	Furnishings
UL GREENGUARD Certification Program	Rigorous third-party chemical emissions standards to reduce indoor air pollution and the risk of chemical exposure	Third-party certification, Single-attribute	Building materials, furniture and furnishings, electronic equipment, cleaning and maintenance products and medical devices
UL Product Lens™ Certification	Exposure risk assessment of construction materials and hazard-based disclosures for complete chemical information in context	Third-party certification, Multi-attribute	Products in the built environment

# Timeline of the Events and Regulations Related to the Chemical Safety and Fire Safety of Residential Upholstered Furniture

Over the past 60 years, fire legislation and fire performance standards have been out of equilibrium with chemical safety, resulting in trade-offs and unintended consequences.

1960s

PATH 1:  
DEVELOPMENT  
OF LEGISLATION &  
FLAMMABILITY  
STANDARDS

U.S. Flammable Fabric Act is amended to include textiles. Concerns about residential fire safety are growing.

1970s

PATH 2: DEVELOPMENT OF STRATEGIES TO SLOW IGNITION

1980s

Furniture manufacturers use additive flame retardants and develop a variety of mixtures, methods, and techniques to meet fire standards.

1990s

2000s

U.S. EPA bans the use of two prevalent mixtures of flame retardants (penta- and octaBDE) and phases out the production of others (decaBDE)

2010s

TB 117 amended

PBDEs are phased out of production, TDCPP is added to California Proposition 65 list.

California replaces TB 117 with TB 117-2013 (a cigarette smoldering test only). California repeals TB 133.

2020s

Policies and Bans

12 states and Washington D.C. pass policies regulating flame retardants.

As part of the "Work from Home Safety Act", TB 117-2013 (cigarette smoldering test only) will become a national testing standard in 2021.

Current State

The fire barrier presents a path towards chemical safety and fire safety.

For more information, see: [Technical Bulletin: Fire Regulations and Flame Retardant Usage Trends](#).

Manufacturers begin adding chemical flame retardants to consumer products, including upholstered furniture, to reduce fire risks.

California issues Technical Bulletin 117 (TB 117), requiring materials of upholstered furniture to pass an open flame resistance test and cigarette smoldering test. It is an optional flammability standard adopted at the state level.

California issues Technical Bulletin 133 (TB 133), requiring open flame testing of seating used in public buildings.

ASTM E1537 is issued as a regulatory test in the International Fire Code and in the NFPA Life Safety Code. ASTM E1537 is identical to TB 133.

Research shows that PBDEs, the most commonly used flame retardants in upholstered furniture, are persistent, bioaccumulative and toxic.

Other commercial mixtures of additive flame retardants are developed to replace flame retardants being phased out of use.

To reduce daily exposure, reactive flame retardants are developed, which chemically bind to polyurethane foam during manufacturing.

Research shows use of a **fire barrier material** in upholstered furniture effectively reduces fire risks without the use of flame retardants.






Today, more people die in home fires that begin with upholstered furniture or mattresses/bedding than any other item.



# Understanding Flammability Standards

Fire safety in commercial and multi-family buildings is regulated by fire codes that mandate the use of sprinklers and means of egress due to their higher occupancy. In single-family homes, however, after initial occupancy permits are acquired, the task of ensuing fire safety is often left up to the resident. Therefore, it is critical that designers consider fire safety as they select furniture and other products for residential spaces — this requires understanding both **fabrication strategies for slowing ignition** and **flammability standards**.

There are **three primary fabrication strategies for slowing ignition** of residential furniture:

 <p>The use of <b>flame retardants in various components of the chair</b> (either additive or reactive chemistries)</p>	 <p>The selection of <b>inherently flame-resistant materials and components</b> (such as leather on a metal frame)</p>	 <p>The use of a <b>fire barrier that encapsulates the cushioning</b> (discussed later in this toolkit)</p>
--	---	--

There are **two primary types of flammability tests** used to evaluate ignition resistance of consumer products:

 <p><b>A cigarette smoldering test:</b> A test that mimics the effect of dropping a smoldering cigarette and assesses the product on its ability to resist ignition. Some smolder tests even use real commercial cigarettes.</p>	 <p><b>An open flame ignition test:</b> A test that simulates a flaming source such as a burning candle or the lighting of a match as the ignition source.</p>
---	---

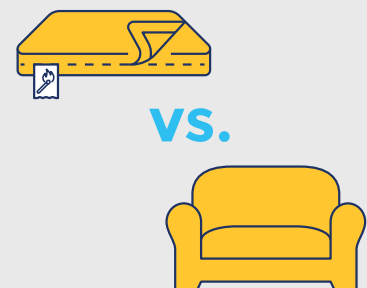
Test types become formalized into flammability standards, which may be optional or formally regulated and adopted at the state or national level. For example, the Consumer Product Safety Commission (CPSC) requires that mattress sets meet federal flammability standards for both cigarette smoldering resistance (16 CFR Part 1632) and open flame resistance (16 CFR Part 1633). As shown in the timeline on the previous page, upholstered furniture standards have not been adopted nationally — until recently.

Historically, due to the lack of a national standard, the California Furniture Flammability Standard, known as Technical Bulletin 117 (or TB 117) became the “de facto” standard in the U.S. for upholstered furniture. When first issued in 1975, TB 117 required the foam or padding in upholstered furniture to withstand both a cigarette smoldering test and an open flame test. To pass these tests, manufacturers often add flame retardants to upholstered furniture — typically more flame retardants were required to pass the open flame test. So, in response to health concerns about potential flame retardant exposures, TB 117 was updated in 2013 to remove the open flame test and leave just the cigarette smoldering test. While this update does not prohibit the use of flame retardants, it does allow furniture to pass the standard without their use.

**Fortunately, advances in technology (the use of a fire barrier) now allow upholstered furniture to pass an open flame test without the use of flame retardants. So, there is no longer a need to sacrifice fire safety to achieve chemical safety.**

## Consider this...

After 30 years of using a cigarette smoldering test, in 2007, the U.S. mandated that mattress sets meet an open flame test and have labels stating that they meet this requirement. The mattress industry has been using fire barrier technologies for over a decade and there are many compliant mattress sets available that do not use fire-retardant chemicals. **Residential upholstered furniture is the leading item first ignited when residential fire deaths are considered. For optimum fire protection, it too can be held to the same flammability requirements as a mattress.**



In December 2020, Congress passed the COVID -19 Regulatory Relief and Work From Home Safety Act, which required that the CPSC promulgate (or promote), TB 117–2013 as a national flammability standard within 180 days. CPSC is expected to codify TB 117–2013 as a final rule in June 2021 with a notice of required labeling requirements to be met by June 2022.

However, TB 117–2013 is a cigarette smoldering test, not an open flame or flaming test. According to NFPA and other studies, 95% of fire deaths occur in the presence of flaming — when fire spreads beyond the upholstered furniture item. This implies that flaming sources are significant and even in smoldering ignited fires, most fire deaths occur after transition from smoldering to flaming.

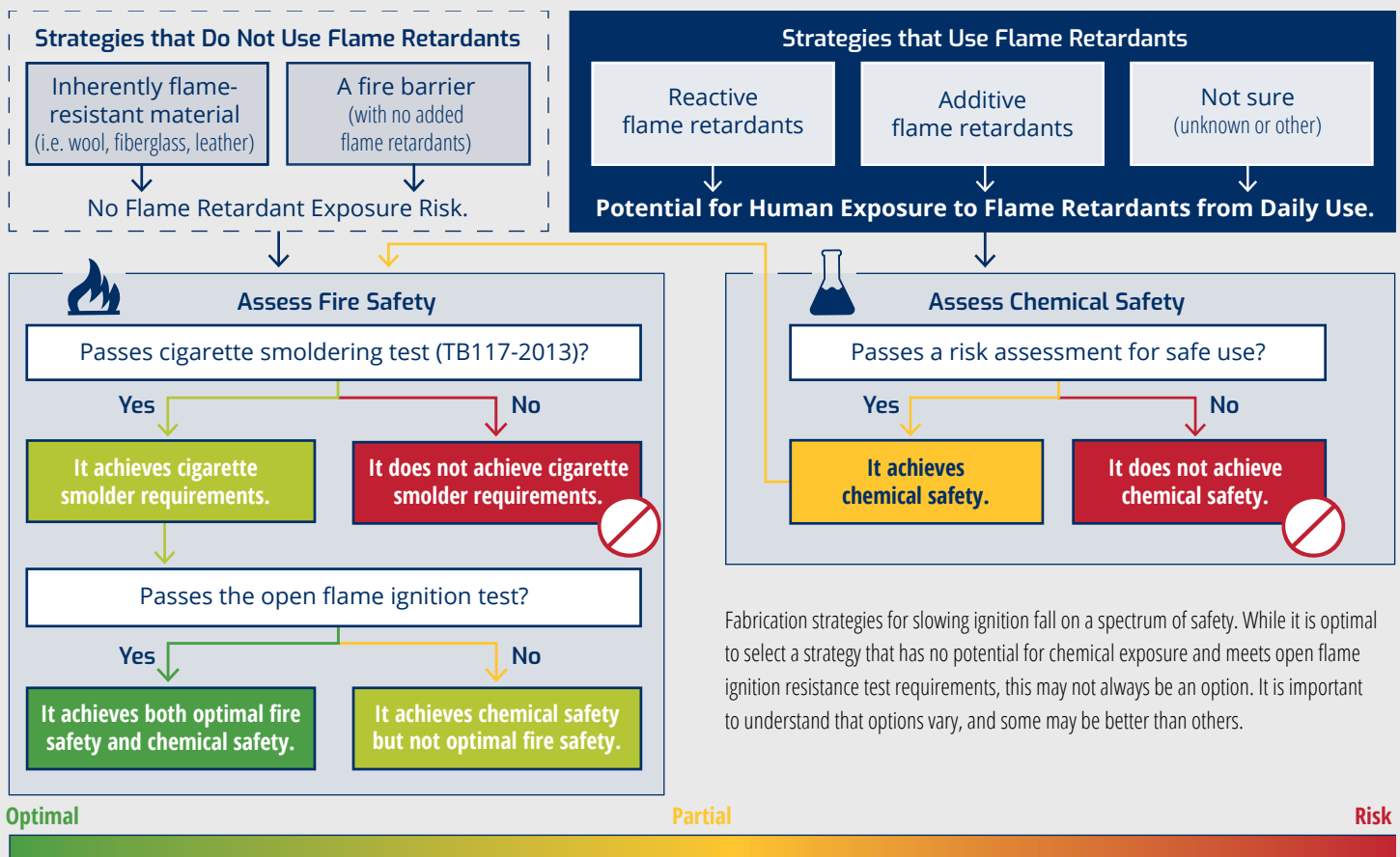
**The bottom line:** While TB 117–2013 is becoming the new national test standard, the data shows that while it can protect against flame retardant exposure, it is a minimum bar regarding fire safety. **By testing to cigarette smolder resistance only, and not an open flame, the ability of residential upholstered furniture to resist flaming ignition or burn at a reduced rate after ignition is minimized and not guaranteed.**

There are plenty of examples where, as a designer, you would recommend going above the bare minimum in the interest of your clients' health and well-being. For instance, you may recommend going beyond the minimum MERV value specified for an HVAC filter or select third-party certified low volatile organic compound (VOC) emission products to support good indoor air quality. In both cases, there are better, safer options available to your clients. This document is meant to present you with all the information and empower you to speak to the limitations of the adopted standard.

**“There are limited data that relate TB 117-2013 to the smoldering ignition resistance of the upholstered furniture item, and there is evidence to suggest that the standard test can underestimate smoldering in residential upholstered furniture due to a reduction in oxygen supply. Additionally, the standard does not require the residential upholstered furniture to resist flaming ignition nor guarantee a reduced burning rate after ignition such that the fire hazard is mitigated.”**

— Fire and Research Division, National Institute of Standards and Technology (NIST), Technical Note 2129

## Considering Fabrication Strategies for Slowing Ignition: A Decision Tree



Fabrication strategies for slowing ignition fall on a spectrum of safety. While it is optimal to select a strategy that has no potential for chemical exposure and meets open flame ignition resistance test requirements, this may not always be an option. It is important to understand that options vary, and some may be better than others.



# The Research: Assessing Chemical Exposure and Fire Performance

To gain scientific insights on achieving both chemical and fire safety for residential upholstered furniture, Chemical Insights, an Institute for Underwriters Laboratories Inc., conducted research on upholstered furniture. The study focused on methodology development for studying pathways for human exposure to flame retardants and assessing exposure amounts during consumer use. It also evaluated the effectiveness of differing fire control strategies on minimizing flammability hazards.

To conduct their research, Chemical Insights partnered with a furniture manufacturer to construct residential upholstered chairs of a model currently available in the market, **utilizing four different strategies for slowing ignition**. These chairs were tested in a variety of different ways, including chemical exposure testing and fire performance testing.



## Four Types of Chairs Utilizing Different Fabrication Strategies for Slowing Ignition

**Chair 1:** A traditional organophosphate chemical flame retardant was added to treat the polyurethane foam.

**Chair 2:** Reactive chemical flame retardant was bound in the polyurethane foam during manufacturing.

**Chair 3:** No flame retardants were added.

**Chair 4:** A fire barrier material was installed to fully encapsulate the polyurethane foam under the cover fabric (no flame retardants were added).

## Two Types of Testing Environments



**Chemical exposure testing** was conducted in an environmental exposure chamber. Both VOC and aldehyde air emissions and flame retardants were measured. During chemical sampling, the chairs were agitated using a specially designed robot to simulate activity from daily use.



**Fire performance tests** were conducted in an ISO 9705 Test Room setup. Both open flame tests and cigarette smoldering tests (according to TB 117-2013) were conducted. Heat and smoke release rates, total weight loss, gas emissions, smoke yield and chemical and dust emissions in the fire effluents were measured.

# Summary of Findings

## Chemical Exposure Testing

Factor	Chair 1: Additive FR	Chair 2: Reactive FR	Chair 3: No FR	Chair 4: Fire Barrier
VOC and aldehyde air emissions	VOC levels below high performance standards	VOC levels below high performance standards	VOC levels below high performance standards	VOC levels below high performance standards
Flame retardant detection	Detected flame retardants in air, settled dust, and dermal transfer	No flame retardants detected	No flame retardants detected	No flame retardants detected

## Fire Performance Testing

Factor	Chair 1: Additive FR	Chair 2: Reactive FR	Chair 3: No FR	Chair 4: Fire Barrier
Heat Release Rates	All three chairs exceeded 1,000 kW of maximum heat release rates. (For comparison, these chairs would not meet the regulatory standard for a mattress, which is 200 kW.)			<b>Maximum heat release rate of 31 kW</b>
Total Weight Loss	Averaged 37.2 lbs. (55%)			<b>5.9 lbs. (8.5%)</b> This reduced heat generation resulted in lower transmitted fire hazards such as temperature, smoke and carbon monoxide.
Chemical Emissions	More than 500 individual VOC species were detected in burn emissions.			
Gas Emissions	Hydrogen cyanide gas, which can lead to lethal poisoning, was detected.			Hydrogen cyanide gas was <b>not detected.</b>

## Images from the Fire Performance Test

Time	Chair 1: Additive FR	Chair 2: Reactive FR	Chair 3: No FR	Chair 4: Fire Barrier
1 Minute				
7 Minutes				
14 Minutes				
30 Minutes				
Chairs 1, 2, and 3 had to be manually extinguished after 15 minutes.				At 30 minutes, the cover fabric was the only element burning.

The chair with the barrier material did not burn to its frame, unlike the other three chairs, and was **the chair that best achieved both chemical safety and fire safety.**

For more information, see: [Chemical Insights' Chair Burn Testing Video.](#)

Open flame testing showed that the chair with a barrier material demonstrated significantly lower fire hazards (in peak heat release rates, carbon monoxide, volatile chemical and hydrogen cyanide emission levels, temperature and smoke) when compared to the other chairs with and without flame retardants (and without barriers). There was no discernible difference in the open flame performance of chairs made with no flame retardant (and without barrier) and those made with flame retardants. Air emissions during the open flame burns showed elevated levels of numerous hazardous chemicals including the organophosphate flame retardant.

In addition, chemical exposure testing showed that VOC inhalation exposure during consumer use was low for all types of chairs. The organophosphorus flame retardant used in this study was found in air, settled dust and dermal transfer samples resulting from use of the specific type of chair. Data showed the most significant human exposure pathway to be dermal transfer from skin contact followed by ingestion and inhalation. Dose determinations indicated that children would receive their highest dose from ingestion primarily resulting from frequent hand-to-mouth contact with settled dust. There was no indication of the “reactive” flame retardant in the environmental samples based on currently available measurement techniques.

For more about this research, see: [Chemical Insights report on Chemical Exposure and Flammability Risks of Upholstered Furniture](#).

## Check it out....

These findings align with a [recent similar study](#) conducted by the Fire and Research Division of the National Institute of Standards and Technology (NIST) on sofas. They found that “the addition of the barrier fabric significantly decreased the fire hazard by reducing the fire growth and delaying room flashover from about 6 to 21 minutes.” Delaying flashover offers valuable time for occupants to evacuate from the space and provides additional time for firefighters to extinguish the fire.

## What is a Fire Barrier?

**By nature, fire barriers are designed to resist open flame ignition sources. However, most designers are not familiar with this option.**

### *What is a fire barrier?*

A fire barrier is a protective layer designed to prevent or delay ignition of the cushioning material. It successfully reduces the fire growth rate and fire size after ignition. Fire barriers can be made from a variety of inherently flame-resistant fibers, including carbons, polyesters and fiberglass.

A barrier should be identified for furniture construction that will delay or reduce open flames.

### *How does it work?*

A fire barrier is installed over the padding or filling materials to completely encapsulate it. In studies, fire barriers have been identified as an effective solution to reduce fire risks without the use of chemical flame retardants — achieving the desired safety convergence. Barriers demonstrate a significant decrease in heat release rate and ignition propensity that results in lower transmitted fire hazards, such as temperature, smoke and carbon monoxide.

### *Why does the barrier encapsulate the foam or padding?*

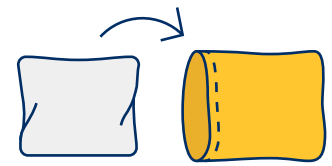
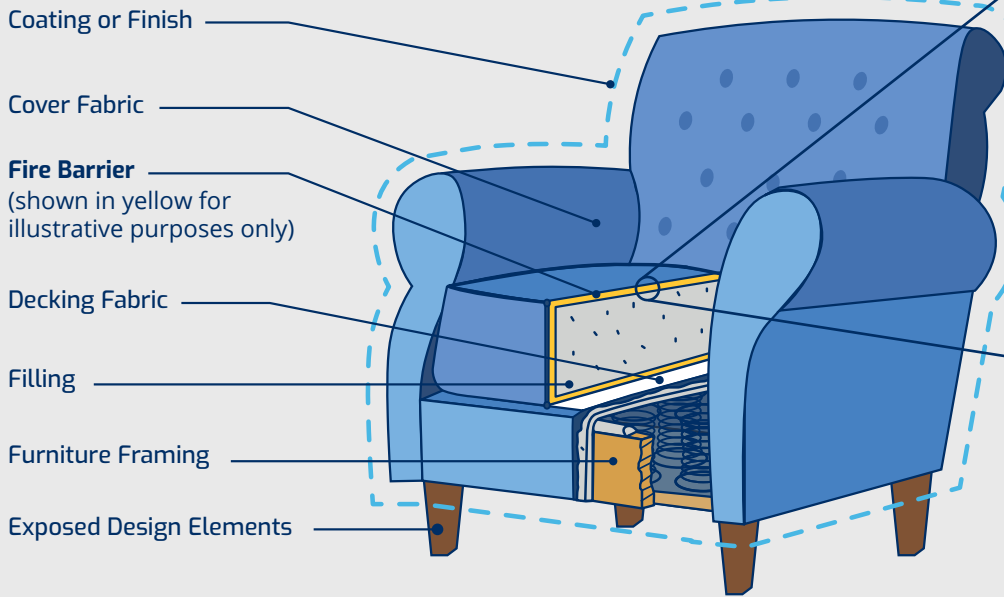
The padding or cushion on a chair act as the main fuel source during a fire.

### *Can you tell if a chair has a fire barrier? Can you feel it?*

When a proper material is specified and installed, the barrier does not impact the final look or feel of the furniture.



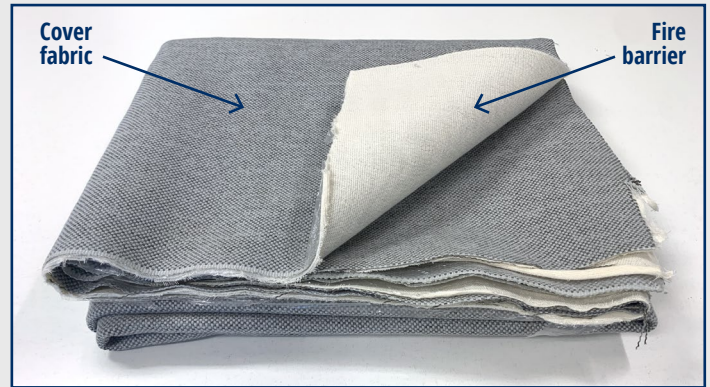
## Components of an Upholstered Chair



The fire barrier material must **fully encapsulate** the polyurethane foam cushion and any padding that can act as a fuel source during a fire.



Fire barrier materials should be soft, pliable and drape well for optimal results.



To simplify installation, the fire barrier can be laminated to the back of the cover fabric.

## Installation Process Using Cover Fabric Laminated with Fire Barrier



1. The fabric pattern (flatwork) for the chair seat cushion is cut out of the cover fabric laminated with the fire barrier.



2. The flatwork for the seat cushion is assembled. Alternatively, the cover fabric and barrier can be stapled.



3. The cover fabric and fire barrier are installed at once, entirely encapsulating the foam cushion.



4. Once the chair is complete, the fire barrier should not impact the final look or feel of the upholstered furniture.

To learn more about how to install a fire barrier, see: [Chemical Insights' Fire Barrier Installation Video](#).

Video, installation photographs and laminated barrier fabric (middle right) photograph courtesy of IOA Healthcare Furniture

Photographs of barrier material (middle left) made possible by Preferred Finishing Technologies



If installed separately, the barrier (shown in gray) must go under the cover fabric and fully encapsulate the foam.

# Specifying a Fire Barrier

Just as identifying materials with recycled content or selecting low-VOC paint were once new concepts, specifying a fire barrier in residential upholstered furniture may be a new process for any or all involved parties — the designer, the client and/or the manufacturer. As with all emerging technologies, utilizing a fire barrier may not be an option on all projects and certainly not on all pieces of upholstered furniture — at least initially. However, you are likely to encounter certain situations that make any additional effort and potential cost worthwhile to the client. And as awareness of and demand for solutions that minimize fire hazards and chemical exposure risks grows, just as with the mattress industry, furniture manufacturers are likely to follow suit. There are already manufacturers in the market using the barrier, upon client request.

As with other emerging technologies related to sustainability or health and well-being, it is your role as a designer to:

**Connect** with your client and bring fire safety into the health and wellness conversation

**Educate** yourself (and potentially the manufacturer) about how to specify a fire barrier

**Advocate** solutions that minimize fire hazards and chemical exposure risks, and ultimately lead to a closed-loop system.

## Connect with the Client

When starting a new project, highlight chemical safety and fire safety issues during initial conversations and discuss their objectives for the project. The goal is not to instill fear, but rather to provide meaningful solutions to client's design challenges. Identify whether they have any existing health conditions or considerations that make the use of a fire barrier especially appropriate. Scenarios may include:

- **Risk of wildfire:** The Insurance Institute for Business & Home Safety (IBHS) has identified 4.5 million U.S. homes as either at “high” or “extreme” risk of wildfire, with more than two million homes in California alone. Clients that live in these wildfire-prone areas may desire peace of mind from flaming fires, particularly for upholstered furniture pieces placed in living rooms and bedrooms.
- **Infants and young children:** Children crawl on the floor and have frequent hand-to-mouth behaviors, which increase potential for exposure to flame retardants and other chemicals of concern. Their small body masses also make them more vulnerable to toxic substances. Additionally, infants are confined in cribs and do not have the ability to escape in the event of a fire. Clients with young children (or planning for future children) should consider using a barrier for any upholstered furniture in nurseries and common spaces where children may play.
- **Accessibility issues:** The NFPA reports that 21% of victims killed in a fire are physically or mentally disabled. Fifty-five percent of fatal home fire victims were 55 years and over and 35% were at least 65 years old. This makes the elderly and individuals with mobility issues especially vulnerable (as they will need more time for escape), making use of upholstered furniture with a barrier even more important.
- **Compromised immune systems:** Individuals with health issues, such as immunocompromised or autoimmune diseases and/or chemical sensitivities are also more vulnerable to toxins. Eliminating chemicals of concern, like flame retardants, from their indoor environment may be a priority.
- **Prolonged exposure to indoor environments:** Studies performed by the U.S. Environmental Protection Agency (EPA) consistently rank indoor air pollution among the top five environmental risks to public health. The average American spends about 90% of their time indoors, where concentrations of some pollutants can be two to five times higher than outdoor concentrations. Individuals who work from home should prioritize source control. In this case, that means eliminating chemicals of concern and protecting their indoor environments from fire.







The fire barrier material, shown in dark gray, fully encapsulates the polyurethane foam cushion before the cover fabric is installed.

## Get Informed

Specifying upholstered furniture with a fire barrier for the first time may require using your investigatory skills and working with a manufacturer to confirm your options, lead times and cost. The barrier will serve as a physical mechanism to delay ignition of the padding materials and reduce fire growth rate when flammable padding is used.

- Fire barriers can be made from a variety of fibers, including knits and nonwovens. They often rely on materials that have inherently improved fire performance, such as fiberglass.
  - Selection of barriers requires a good fabric hand. Fabric hand is the assessment of the quality of the fabric specific to the function for factors of flexibility, rigidity and softness, allowing it to be wrapped around resilient materials that may need additional protection to reduce flammability. When properly specified and installed, the fire barrier should not impact the final look or feel of the upholstered furniture.
  - At a minimum, specify that the barrier completely encapsulate the foam seat cushion. Depending on the design of the chair, it may also be necessary to encapsulate additional padded components such as back and arm cushions.
- Confirm that all chair materials, including the barrier, cover fabric, decking fabric and chair frame, do not contain flame retardants. It can be difficult to determine if a piece of furniture contains flame retardants. Manufacturers are usually not required to disclose this information, and some may not even be aware that their product contains flame retardants.
  - Collect documentation for material review, including supply chain verifications, certifications and verifications for fire and chemical safety tests and special attributes, and material transparency resources (such as those highlighted earlier).
  - Furniture sold in the state of California should have a label that indicates whether flame retardants are present.
- Additionally, select low-VOC materials to minimize potential exposure to chemicals during daily use.
- When possible, select other textiles, such as cover fabrics and backing materials, and furniture materials with inherent flame-resistant properties.
  - The natural fibers of wool, silk and leather are more difficult to ignite than synthetic fibers, burn slowly, and may self-extinguish.
  - Fabrics made from synthetic fiber blends may or may not have flame retardants integral in the chemistry. Typical thermoplastic synthetic fabrics, such as polypropylene, nylon or polyester tend to melt.
  - Select metal framing to reduce flammability. If metal is not available, consider selecting hardwood framing and avoid the softwoods common in the marketplace
- Identify any additional costs associated with the installation of the barrier. These may include material costs and labor costs. Potential added costs should be considered and balanced related to the client's safety and health considerations.
- If flame retardants are used to meet programmatic requirements, ensure that chemical risk assessments have been conducted and acceptability is confirmed.

## Advocate for Chemical Safety and Fire Safety

Designers play a key role in moving the industry forward through advocacy. Human health and well-being can be protected when quality, affordable fire barriers become standard in residential upholstered furniture.

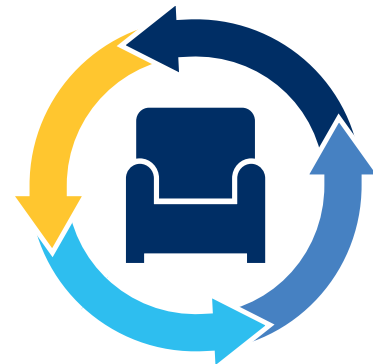
**To support this effort, designers can advocate for fire barriers that are:**

- Widely available and commonly offered,
- Free of hazardous chemicals,
- Durable over the life of the product,
- Comfortable and invisible to the user, and
- Affordable to consumers.

In addition to human exposure, the overall environmental impact of flame retardant usage in residential upholstered furniture should also be considered. The life-cycle of a piece of furniture encompasses raw material extraction, manufacturing, use and end-of-life including reclamation. The furniture industry, among many other industries, is transforming from a linear supply chain system toward a closed-loop system, attempting to shift the economy from an extractive framework to a sustainable, regenerative one.

**Furniture fabrication already has many elements in place that lead to a closed-loop system, including:**

- Furniture made to last generations,
- An aftermarket of professional tradespeople who can extend longevity of upholstered furniture, such as upholsterers and secondary markets that support furniture reuse through donation and resale, and
- Reupholstery components, like metals, foam and cotton, that can be diverted from the landfill into downstream recycling markets, and remnant fabrics that can be sold or donated for reuse.



But, complications to this system occur when persistent chemicals such as flame retardants are present. Therefore, it is best to replace chemicals of concern in newly manufactured residential upholstered furniture with safer alternatives.

**Furniture that is both free of hazardous chemicals and designed with fire safety in mind best fits into the closed-loop system we're all striving to achieve.**

**For more information on *Furniture Flammability and Human Health (FFHH)* initiatives, visit: [www.chemicalinsights.org/FFHH](http://www.chemicalinsights.org/FFHH)**



As an Institute of Underwriters Laboratories Inc., Chemical Insights is a non-profit organization that delivers the scientific insight policymakers, healthcare providers, business leaders and consumers depend on to make informed environmental health decisions.

Our mission is to advance safe and healthy working, learning and living environments. All of our amassed knowledge, scientific studies, rigorous laboratory testing, collaboration, and published materials share this critical mission — to sustain a healthy environment for all people globally.

To learn more visit: [www.chemicalinsights.org/education](http://www.chemicalinsights.org/education)

