



Testimony of UL

**Hearing on the Effectiveness of Upholstered Furniture Flammability
Standards and Flame Retardant Chemicals**

**Senate Appropriations Committee
Subcommittee on Financial Services and General Government
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Statement of

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Thank you Chairman Durbin, Ranking Member Moran and distinguished members of the Subcommittee for the opportunity to share UL's research and expertise on the subject of furniture flammability. My name is Gus Schaefer – Senior Vice President and Public Safety Officer at UL.

UL (Underwriters Laboratories, Inc.) is an independent, not-for-profit standards developer and product testing and certification organization dedicated to public safety. Since our founding in 1894, UL's engineers and staff have helped develop safety standards and product-testing protocols, conducted independent product safety testing and certification, and inspected manufacturing facilities around the world. UL is driven by our global safety mission, which promotes safe living and working environments by the application of safety science and hazard-based safety engineering. The application of these principles manifests itself in the evaluation of tens of thousands of products, components, materials, and systems for compliance to specific requirements. Through these activities, UL actively engages the US government in its development and administration of federal regulations and conformity assessment programs at the federal, state, and local levels. UL works with all participants as a neutral party to ensure the safest possible outcome for those who work with and rely on the products at issue.

Fire Risk Associated with Upholstered Furniture

According to the National Fire Protection Association (NFPA), more home fire deaths resulted from fires beginning with upholstered furniture and mattresses/bedding than any other cause. During the five-year period of 2005-2009, these fires accounted for 19% and 14% of the deaths and 7% and 10% of the injuries respectively. They also accounted for \$824M in direct property damage.¹

During the past 30+ years, residential interiors have changed dramatically. Homes have increased in size, the number and amount of furnishings and possessions have grown, and petroleum-based synthetic materials have supplanted natural materials in furnishings and home construction products. The combination of these factors has changed the smoke and gas characteristics of residential fires and in some cases, accelerated the speed of fire growth.

For a variety of reasons, manufacturers of home furnishings are turning away from materials like wood and natural fibers in favor of high-performance, lower-cost synthetic materials. For example, most upholstered furniture available today utilizes polyurethane foam for padding and synthetic fabric covers, replacing natural padding materials like cotton, down and feathers, and cover materials made of cotton, wool, linen or silk. While these material changes can lead to products that are easier to clean and more resistant to normal wear and tear, they also react differently when exposed to an ignition source. Studies by UL researchers have found that synthetic materials typically ignite faster, burn more intensely, and release their fire-enabled energy faster creating greater amounts of smoke than natural materials posing a more ominous threat to occupants and their homes.²

The video that will be playing first will show a side-by-side comparison of a room filled with legacy furniture, or furniture you would expect to find in a home in the 1960's and 70's, and a room with

¹ NFPA; "Home Structure Fires," August 2011; <http://www.nfpa.org/assets/files/pdf/os.homes.pdf>

² Fabian, T.Z, and Gandhi, P.D., "Smoke Characterization Project: Technical Report", UL, April 2007. (Available at <http://www.nfpa.org/assets/files//PDF/Research/SmokeCharacterization.pdf>.)

modern furniture purchased at a national department store chain. Both rooms were ignited by placing a lit stick candle on the right side of the sofa and the fires were allowed to grow until flashover. As you will see, the room with modern furniture achieves flashover conditions in a significantly shorter time.

The seemingly insignificant change from natural to synthetic materials in home furnishings has led to residential fires that grow faster and lead to the more rapid onset of untenable conditions. As a result, the amount of time available for safe egress from a home fire is much shorter than in the past. These results corroborate the National Institute of Standards and Technology's (NIST) findings for shorter available safe escape times in residential smoke alarm studies conducted in 2003³ versus 1975⁴ which they attributed in part to faster fire growth.

UL Research Exploring the Fire Safety of Upholstered Furniture

As part of UL's safety mission, in 2008 we set out to conduct a self-funded research project to determine if commercially available products such as fire retardant foams and fire barriers (interliners) can retard and/or reduce the fire growth rate of upholstered furniture exposed to small open flames. Polyurethane (PU) foams are highly cellular materials that provide flexibility and comfort. Unfortunately, the physical design and chemistry (polyurethane chemical structure) is highly vulnerable to ignition, flaming liquefaction and further burning. Flame retardants (most notably bromine and phosphorous) are used to quench the progressing fire growth. Because of the cellular foam structure, the quantities of FR necessary to accomplish this task are extremely high, some as high as upwards of 30 percent by weight. Fire barriers are complex woven structures that have both polymeric fibers and inorganic coatings that develop a protective char on burning. When they are exposed to high temperature flames, the organic polymers burn with the inorganic compounds and form combustion products that are brittle and have mechanical strength (rather than powdery ash). The creation of an inorganic "crust" is a way of slowing down or even preventing the high temperature flames from impinging on the PU foam. There are many other examples of intumescent or char forming materials, such as intumescent coatings for steel beams, and polymeric jacketing materials used in plenum cable.

UL decided to focus our research on open flame testing as we believed that the Consumer Product Safety Commission (CPSC) and the Upholstered Furniture Action Council (UFAC) were already addressing smoldering ignition. The scope of the project later expanded to fully understand the impact upholstered furniture materials play in fire growth and subsequent occupant tenability and survivability. Thus, apart from the ignition of upholstered furniture, our research sought to understand the dynamics of fires that include various constructions of upholstered furniture.

Our research can be divided into three phases. Phase 1 of our research consisted of material-level tests, furniture mock-up tests, and full-size furniture tests, the original scope of the study. Phase 2 compared various upholstered furniture configurations in a living room environment. Finally, Phase 3 included a series of full-scale house fire experiments to determine smoke alarm response and occupant tenability and survivability related to upholstered furniture fires.

³ Indiana Dunes II: Bukowski, R.W. et al, "Performance of Home Smoke Alarms – Analysis of the Response of Several Available Technologies in Residential Fire Settings", NIST, January 2008.

⁴ Indiana Dunes I: Bukowski, R.W. et al, "Large-Scale Laboratory Tests of Smoke Detectors", NIST, 1975.

Phase 1: Material, Mockup, and Full-Sized Furniture Testing

Materials utilized in this investigation included eleven commercially available barrier materials constituting different chemistries and physical structures (including flat weaves, knits, and high lofts). Two comparable density polyurethane foam materials were also used: a non-fire retardant foam commonly used in upholstered furniture and a California TB 117 compliant fire-retardant treated foam. UL also utilized the most popular cover fabric from the largest upholstered furniture cover fabric supplier in the United States (CPSC 16 CFR Part 1634 Type I compliant beige polyester microsuede).

Tests were conducted on three scales of combustibility: (1) material-level tests, (2) furniture mock-up tests, and (3) full-size furniture tests. The combustibility behavior of the individual sample materials and combinations of materials (i.e. foam/barrier liner/cover fabric) under well-ventilated, early stage flaming fire conditions was characterized using a cone calorimeter (ASTM E 1354). In the furniture mock-up tests, cushions of the foam and barrier liner combinations evaluated in the material-level test phase were arranged to replicate an interior corner formed by the seat, back, and arm of a chair or sofa. The furniture mock-ups were ignited at the interior intersection of the three cushions using a BS 5852 Flaming Ignition Source 1 (match-flame equivalent). For the full-size furniture test, three of the foam and liner barrier combinations were compared to typical residential materials. Furniture pieces were ignited at the seat-back-arm interior corner, center of the seat-back cushions, and at the back leg area using the same BS 5852 Flaming Ignition Source 1 (match-flame equivalent) as for the furniture mock-ups. Heat release rate and mass loss rate were measured in both instances.

The results of Phase 1 indicated that contemporary furniture constructed with California TB 117 compliant fire retardant-treated foam show measurable difference in the time to flashover but not a meaningful difference compared to contemporary furniture constructed with a non-fire retardant foam commonly used in upholstered furniture. In addition, when a flame suppressant technology such as a flame barrier is used between the decorative fabric and the foam, then this furniture (manufactured to UL specs with polyurethane foam) behaves closer to “legacy” furniture. Specifically, the time to flashover is increased to greater than 20 minutes – which would allow residents significantly more time to safely get out of their homes.

The results of these experiments provide knowledge on the potential fire growth reduction for the different investigated strategies, implementation feasibility, the interaction between different chemistries and components, and the influence of test scale and sample design on fire performance. Collectively this information can be used by researchers, manufacturers and industry associations, and regulators such as the Consumer Public Safety Commission (CPSC) and California Bureau of Home Furnishings and Thermal Insulation (CA BHFTI) to establish appropriate technical requirements, and a corresponding compliance program, for upholstered furniture akin to the CPSC program for mattresses.

Phase 2: Comparison of Upholstered Furniture on Living Room Flashover

As you will see in the second video, in Phase 2 we conducted a series of fires in a living room environment to better understand the impact upholstered furniture materials have in fire growth. The room environments were identically furnished with an engineered wood television stand, book case, coffee table, and end tables purchased from a national department store chain. In addition, the rooms had other fuel loads such as a 37 inch flat panel display television, plastic toy bins, stuffed toys and

polyester curtains. The only differences in the rooms were the materials used in the upholstered chair and sectional sofa. The top left screen contains contemporary upholstered furniture with polyester wrap covered polyurethane foam cushions, and polyester microsuede cover fabric. The top right screen is furniture constructed in legacy materials such as cotton batting around metal spring cushions and cotton cover fabric. The two bottom screens consist of barrier modified contemporary upholstered furniture with high-loft fire barrier covered polyurethane foam cushions and polyester microsuede cover fabric. The fires were ignited by placing a lit candle on the right side of the sofa and allowed to grow until flashover. One of the barrier modified sets of furniture was ignited in the center of the sofa where the seat and back cushions for two spots meet.

At 0:45 seconds we can already see that the flame size on the contemporary furniture is growing at a faster rate than the other furniture pieces. At the 1:00 minute mark, the smoke alarm would have activated to notify the occupants. We can assume it would take an occupant at the earliest about 20-40 seconds to recognize the danger and to take appropriate actions, such as finding a fire extinguisher. At 1:45 the fire in the contemporary furniture environment would be difficult to handle with a fire extinguisher and the occupant would then look to escape. On average, people take 60 – 90 seconds to dress, call 911, gather personal belongings and awaken two children. Once a call is placed to 911, a dispatcher will alert the local fire department to head to the scene. The Chicago Fire Department is the nation's 2nd largest department and their goal is to be on-scene within 3-5 minutes after dispatch. Other departments may take longer such as those servicing rural areas. Additionally, this is just the time for the fire service to arrive; once at the scene, they still have to assess the scene.

The room furnished with contemporary upholstered furniture in the top left of screen transitioned to flashover at 4 minutes and 45 seconds. At 15:00 the fire started at the interior corner of the barrier-clad contemporary furniture has self-extinguished. Flashover occurs for the barrier clad contemporary furniture ignited between the seats at 21:45 which is 17 minutes later than the identical furniture that does not have the fire barrier. At 34:15 the living room furnished with legacy furniture flashes over, consistent with what we found for the used furniture in the Modern vs. Legacy side-by-side video. From this video, we can deduce that rooms furnished with contemporary furniture often reach flashover point prior to the fire service arriving at the scene of the fire.

Phase 3: Comparison of Upholstered Furniture on Occupant Tenability and Survivability

Based on the data drawn from Phase 2 and exemplified in the second video that you just witnessed, UL wanted to determine what the smoke alarm response and occupant tenability and survivability in an actual full scale home. In March of 2012 a series of full-scale house fire experiments was conducted in UL's large fire facility. One house was a one-story, 1200 square-foot, 3 bedroom, 1 bathroom house (8 rooms total); the second house was a two-story 3200 square-foot, 4 bedroom, 2.5 bathroom house (12 rooms total). The second house featured a contemporary open floor plan with the two-story great room and foyer open to the upstairs bedrooms.

The living/great rooms were identically furnished with engineered wood television stand, coffee table, a lamp, and end tables purchased from a national department store chain. The only furnishings that differed in the tests were the materials used in the upholstered chair and sectional sofa. The contemporary furniture was constructed using the same hardwood frames but one set consisted of polyester wrap covered polyurethane foam cushions, polyester microsuede cover fabric while the other introduced a high-loft fire barrier to cover the polyurethane foam cushions. The fires were

ignited by placing a lit candle on the right side of the sofa and allowed to grow until temperatures in a remote location from the fire reached an unsurvivable level of 150 °C (302 °F). Preliminary data analysis supports Phase 2 findings but we are still currently analyzing the results of these recent experiments.

Conclusions

Based on the research we conducted, UL believes:

One, that the typical flame retardant chemical concentrations used to meet fire regulations in upholstered furniture do not provide for sufficient fire egress times. The most common of those fire regulations is the California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation's TB 117 performance requirements.

Two, that when a flame suppressant technology, such as a flame barrier, is used between the decorative fabric and the foam, then this furniture (manufactured to UL specs with polyurethane foam) behaves closer to "legacy" furniture. Specifically, the time to flash over is increased to greater than 20 minutes – which would allow occupants significantly more time to safely evacuate their home and allow for fire service to respond to the fire.

Three, that barrier materials need not be made of a chemical flame retardant that may or may not pose a negative impact on human health or the environment. It is conceivable that manufacturers could incorporate various innovative barrier methods in upholstered furniture with minimal impact on current manufacturing methods. Some types of barriers such as high-loft barriers could be used as a replacement for polyester wrap thereby minimizing impact on manufacturing and labor. Other barriers, such as flat barriers similar to those incorporated by the mattress industry, could pose an additional manufacturing step, but do yield increased fire safety performance.

In addition to fire research UL has conducted on upholstered furniture, UL has also conducted studies in cooperation with the Fire Protection Research Foundation (a foundation under NFPA) on smoke characterization to understand smoke associated with materials commonly found in residential homes today and to provide data points to develop better smoke sensing technology or smoke suppression technology in end products. UL also has the ability to measure consumer exposure and indoor air quality to flame retardant and alternative chemicals under normal use conditions and during combustion or fire processes for the measurement of toxic byproducts using environmental chamber technology. This technology allows the study and impact of alternative construction techniques like the use of fire barriers, reduction of synthetic materials, petrochemical based construction materials; and the use of alternative, less toxic flame retardants for bedding, furniture, construction materials, and electronics. This allows for system and component analysis under normal and abnormal conditions to help facilitate the development and validation of chemically safe, fire-resistant products.

UL appreciates this Committee's interest in furniture flammability related matters and how all parties can work to enhance public safety. We appreciate the opportunity to share our knowledge and look forward to working with you and other stakeholders moving forward.

If you have any questions or would like to discuss elements of this submission, please contact Khoi Do, UL's Global Government Affairs Senior Specialist for Product Safety. (khoi.do@ul.com)

Enclosure: Additional Resources for Submission