RESEARCH REPORT

UPHOLSTERED FURNITURE FLAMMABILITY

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Issue date: July 31, 2013
EXECUTIVE SUMMARY

Upholstered furniture was identified as a source of dangerous fire potential forty years ago in the 1973 report “America Burning” written by the National Commission on Fire Prevention and Control. In the report smoking was identified as the predominant source of upholstered furniture fires. Since then considerable attention has been given to reduce fires and associated losses stemming from smoking related ignition sources including development of voluntary standards and mandatory regulations, campaigns to curb smoking, and regulations and campaigns to increase the presence of smoke alarms in households.

Between 1980 and 2009, residential structure fires originating with upholstered furniture declined from 36,900 to 5,600. While the number of upholstered furniture fires has been significantly reduced since 1980, they remain persistent and deadly. During the 2006 to 2010 time period these fires resulted in annual averages of 480 civilian deaths, 840 injuries, and more than $427 million in direct property damage. The National Fire Protection Association (NFPA) reported that “fires beginning with upholstered furniture accounted for 2% of reported home fires but one of every five (19%) home fire deaths.”

Considerably less attention has been given to fires beginning from open flame ignition of furniture. Small open flames such as candles, matches or lighters represent a different exposure threat than smoldering induced by smoking materials or heating equipment. Upholstered furniture fires started by small open flames are more likely to spread to the surrounding room and residential structure than fires started by smoking materials.

During a home fire, upholstered furniture can become a significant fuel source. When exposed to an open flame, this furniture can substantially contribute to a room’s time to flashover. Limiting the fire growth from an upholstered furniture item can improve occupant safety and likelihood of safely escaping.

UL, a leader in fire safety for over a century, initiated a self-funded exploration study in 2008 to explore whether or not commercially available products such as flame retardant treated foams and fire barriers (interliners) can retard and/or reduce the fire growth rate of upholstered furniture exposed to small open flames. This study was an extension to what was learned for mattresses (another significant source of fuel in a home fire) following the 2006 Consumer Product Safety Commission’s Standard for the Flammability (Open Flame) for Mattress Sets.

Eleven commercially available barrier materials constituting different chemistries and physical structures (including flat weaves, knits and high lofts); two comparable density polyurethane foam materials, a non-flame retardant foam commonly used in upholstered furniture and a

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California Technical Bulletin (TB) 117 compliant fire-retardant treated foam; and the most popular cover fabric from the largest upholstered furniture cover fabric supplier in the USA were included in the investigation.

The investigation covered three scales of combustibility: (1) material-level experiments, (2) mock-up experiments, and (3) full-size furniture experiments. 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. In the mock-up experiments, cushions of the foam and barrier liner combinations evaluated in the material-level experiment phase were arranged to replicate an interior corner such as that formed by the seat, back, and arm of a chair/sofa. The mock-up arrangements were ignited at the interior intersection of the three cushions using a match-flame equivalent gas burner. Heat release rate and mass loss rate were measured under an open calorimeter. Combustibility of full-size chairs and sofas made from four of the foam and barrier liner combinations was compared. Furniture pieces were ignited at a seat-back-arm interior corner, center of the seat-back cushions, and the back leg area using the same match-flame equivalent gas burner as for the mock-up assemblies. Heat release rate and mass loss rate were measured under a product calorimeter.

While this investigation was by no means all encompassing, particularly with regards to the flame retardant treated foam and the commercial applicability of the tested fire barrier and foam materials, data from the cone calorimeter material-level, intermediate calorimeter mock-up, and full-scale furniture testing indicate the following:

- The three investigated general fire mitigation approaches for upholstered furniture (substitution of foam without fire retardants with flame retardant treated foam, substitution of polyester wrap with high-loft fire barrier, and inclusion of a flat fire barrier between the cover fabric and polyester wrap) demonstrated some degree of reduction in ignitability and/or flammability.

- A layer of smooth bond polyester wrap (used to “soften” cushion edges) was sufficient to make the investigated fire-retardant treated foam indistinguishable from the untreated foam.

- Fire barrier technology, i.e. material chemistry and physical form, played a significant role on ignitability and combustibility; however, all of the sample combinations incorporating the fire barriers exhibited greater fire resistance than the polyester wrapped polyurethane foam cushion with or without flame retardant.

- Fire barriers were more effective retarding fire growth than the flame retardant treated foam meeting the minimum performance requirements specified in TB 117. It should be noted that TB 117 only prescribes a minimum performance level and that other compliant foam products utilizing different flame retardant chemistries and/or concentrations may yield more significant results.

- Inclusion of an investigated fire barrier significantly retarded self-sustained flaming and fire growth rate in upholstered chairs. This slower growth rate could delay or even prevent room flashover thereby potentially reducing occupant deaths and injuries and property damage.

- Poor seam construction can compromise the effectiveness of fire barriers.
ADDITIONAL INFORMATION
Supplemental to the research presented herein, a series of living room fires and house fires were conducted to better illustrate the impact upholstered furniture materials play on fire growth and subsequent occupant tenability and survivability. These experiments were limited to a few combinations of materials. An overview can be found at www.ul.com.

RECOMMENDATIONS FOR FUTURE RESEARCH
Based upon the results of this Project, the following were identified as areas that would benefit from further research:

- Assessment of new fire barriers not available at the time of this investigation
- Broader study of flame retardant treated foams with regards to flame retardant chemistry and concentration effects on upholstered furniture flammability
- Impact of filling materials other than polyurethane foam on upholstered furniture flammability
- Combinations of flame retardant treated foam, other filling materials, and barriers
- Smoldering ignition resistance of fire barrier clad upholstered furniture
- Further refinement of small-scale predictive flammability test methods
- Assessment of furniture geometry impact on upholstered furniture flammability
- Impact of aging and use on the flammability of upholstered furniture constructed with fire barriers and/or flame retardant-treated foams
- Impact of the slower fire growth rate in upholstered furniture on the time to room flashover
- Impact of the slower fire growth rate in upholstered furniture on occupant tenability and survivability
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