Technical Bulletin
center for the polyurethanes industry
January 2008
Doc # AX-239

# Flexible Polyurethane Foams (FPFs) Used in Upholstered Furniture and Bedding

## Flexible Polyurethane Foams – The Basics

Flexible polyurethane foams (FPFs) are all around us, in our homes, vehicles, schools and businesses. They are outstanding cushioning material with many desirable physical properties, including light weight, resiliency, low odor and, as an open-celled system, the ability to quickly recover after compression. They can be produced with a wide variety of cushioning and load bearing characteristics. Because of these desirable properties, FPFs are widely used in upholstered furniture and bedding. This Technical Bulletin will only address use of FPF used in upholstered furniture and bedding.

FPF is manufactured by reacting a polyol and diisocyanate in the presence of blowing agents and other additive chemicals such as catalysts, surfactants, antioxidants and colorants. Additionally, some formulations include flame retardants. For upholstered furniture and bedding, FPF is produced as a slabstock. To make slabstock, the mix is poured onto a conveyor, where it reacts and expands into a continuous slab. The slab is then cut, stored and allowed to cure for up to 24 hours before it undergoes fabrication.

This Technical Bulletin has been designed to address some fire safety guidelines for FPF in existence as of the publication date of this document. These guidelines are not exhaustive and should be used only as a starting point for fully understanding standards for upholstered furniture and mattresses.

## FPF and Combustibility

As is the case for any organic material, FPF will burn if exposed to a sufficient heat source. The open-celled structure of FPF contributes to its ability to combust. Combustion characteristics of any material involve factors such as ease of ignition, propensity to smolder, surface flame spread, rate of heat release, total heat release, fuel contribution, and products of combustion, including smoke and gases.

Some of the combustion characteristics of FPF can be altered by varying formulations and including the use of flame retardants and other additives during production. Whether it contains flame retardants (FRs) or not, all FPF should be considered combustible and handled accordingly. When used in upholstered furniture and bedding, FPF, used in combination with fabric coverings, polyester fiber and other materials, can significantly influence the combustibility of the finished article.

Fire tests of products containing FPF have been conducted by manufacturers, government agencies, and other organizations both in the United States and in the United Kingdom. Ignition sources for fire tests have included cigarettes, methenamine pills, newspapers, and gas burners. Tests indicate that the combustibility characteristics of upholstered furniture vary according to the covering types, configuration of the final assembly, formulation of the foam, and ignition source. In fire testing of products, it is important to determine the combustibility of the completed assembly as well as the component parts. Small scale laboratory tests have a function in identifying combustibility characteristics of materials and can be used as screening tools and for product development, but they should not be used to predict the behavior of an assembly or material in an actual fire situation. Tests have shown that the use of certain flame retardant backcoated fabrics or interliners between the covering and filling materials of an article can significantly increase the article's resistance to flaming ignition and flame and other combustion products.[1]

## Polyurethane Products in Fires and the Toxicity of Smoke

All combustible materials, including FPF, produce toxic smoke when burned. The principal gases have been identified as carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxides (NOX), and hydrogen cyanide (HCN). In addition, some amounts of other chemical compounds may be emitted from polyurethane fires.

There are misconceptions that smoke from a fire that involves polyurethane products must pose a significantly greater health risk than from other synthetic or natural materials because hydrogen cyanide (HCN) is present in the smoke. HCN is produced whenever nitrogen containing materials are burned, including polyurethanes and other common materials such as sheep's wool. However, in terms of hazard, carbon monoxide (CO) is by far the most abundant toxicant in fires under almost all combustion conditions.[2,3,4]

## Combustibility Standards and Regulations for Bedding and Upholstered Furniture

The most common causes of fires originating in bedding and furniture have been identified as lighted cigarettes and other smoking materials[5,6]. In fact, the Consumer Product Safety Commission (CPSC) has stated that about 83% of fire deaths from upholstered furniture fires were ignited by smoking materials.[7] Also of concern, however, are the number of fires in bedding or furniture that result from small open flames like matches, cigarette lighters, candles, or other sources. The Center for the Polyurethanes Industry of the American Chemistry Council (CPI) has recognized the importance of reducing the incidence of fire deaths and injuries associated with residential upholstered furniture and mattresses. It released a Position Statement in 2001 calling for the development of a technically sound, effective national standard for these products (see CPI's website at www.polyurethane.org to view the entire position statement). Additionally, CPI has conducted flammability tests to help support the development of a standard and worked with school districts to enhance fire safety education at the elementary class level.

## Mattresses-A Federal Standard Takes Shape

Since 1972, mattresses have been required to conform to the CPSC standard, which is codified as 16 CFR 302 Part 1632, Flammability Standard for Mattresses. This standard includes a cigarette smoldering test in which a specific number of burning cigarettes are placed at key locations on the test mattress. The results of this test are reflective only of a bare mattress and are not of typical mattress/bed clothes performance. It should be noted that although this test is deemed to provide consumer protection against ignition from low heat sources such as smoldering cigarettes, it does not predict the performance of a mattress once it has become involved in an actual fire.

On July 1, 2007, the CPSC's new standard, the Federal Open-Flame Mattress Standard took effect. This standard sets mandatory national fire performance criteria for all mattresses, and requires testing mattresses with substantial side and top gas ignition burners. Through testing of typical bedding, the heat output was estimated and reproduced in the gas burners. The mattress test requirements are that 1) it generates less than 15 Mega joules (MJ) of total heat release during the first 10 minutes of the test and 2) it produces a peak heat release rate of less than 200 Kilowatts (kW) during the 30 minutes following ignition. CPSC reports this heat output should keep a room from going to flash over (16 CFR Part 1633).

The CPSC is considering a request by the mattress industry to modify or rescind the cigarette smoldering standard (Part 1632) since mattresses that pass the Part 1633 open flame test are expected to also pass the cigarette smoldering test. As of the date of this publication no decisions have been made by the CPSC.

In January 2005, CPSC published an Advance Notice of Proposed Rulemaking (ANPR) requesting public comments regarding whether the agency should

propose a flammability standard for bedclothes (which would be codified as 16 CFR Part 1634) (70 FR 2514; January 13, 2005). These types of products would include polyurethane products including comforters and pillows. As of the date of publication of this Technical Bulletin, CPSC has not issued a proposed rule.

## Upholstered Furniture- A Federal Standard

There are no federal standards governing the combustibility of upholstered furniture. The CPSC has been researching both cigarette smoldering and small open flame ignition sources such as matches, cigarette lighters and candles for a possible standard since 1994. The CPSC has reviewed fire resistant fabrics, fire blocking interliners and flame retardant treated cushioning materials, but as of the publication date of this Technical Bulletin, CPSC has not issued a final rule.

## Upholstered Furniture- Voluntary and State Standards

In 1974, the furniture industry created the Upholstered Furniture Action Council (UFAC), which established and maintains voluntary standards for the manufacturing of upholstered furniture that resists ignition from smoldering cigarettes. From 1980 to 2002, this program and other factors, along with the reduced number of smokers, increased use of smoke detectors, and consumer fire safety education programs, have contributed to a decline in upholstered furniture fires and resultant deaths by about seventy-six percent and sixty-three percent, respectively.[5]

The California Bureau of Home Furnishings has promulgated two regulations regarding the fire performance of upholstered furniture. California Technical Bulletin TB-117 subjects components of residential furniture to an open flame and smoldering cigarette in a small test chamber. California Bureau of Home Furnishings has initiated a process to revise TB-117 and issued a new draft standard (2002) generally referred to as TB-117+ because of stricter pass/fail criteria. No further action has been pursued on this draft standard at the time of this publication.

California Technical Bulletin TB-133 sets flammability standards for furnishings in areas of high risk including but not limited to hospitals, nursing care facilities, and prisons. It also sets flammability standards for buildings open to the public that do not contain sprinkler systems. The standards subject a full piece of furniture or an assembled “mock-up” to a severe “large open” flame test. The Port Authority of New York and New Jersey and the Boston Fire Department also have established combustibility standards for upholstered furniture in their respective jurisdictions, with test requirements mirroring TB 133.

## Handling and Storage of Flexible Polyurethane Foam

Large amounts of FPF assembled in one place, such as for processing into finished products or in storage, present a potential fire hazard. Once ignited, these foams can produce intense heat, dense smoke, toxic gases and at higher temperatures form flammable liquids that may spread the flames rapidly. General fire safety management procedures that apply to storage of other combustible materials also apply to the storage of FPF. These include building location, construction, detection, alarms and suppression systems, smoke venting, floor drainage, personnel training, and housekeeping.

For these reasons, handling and storage procedures for FPF and fabricated items often include indoor storage, away from fabricating operations, and protection by automatic sprinklers. Ignition sources such as smoking materials, open flames, exposed heating elements and bare light bulbs should be kept an adequate distance away from storage and fabricating areas. Preventing scrap foam from accumulating, and the prompt and proper disposal of scrap foam, is also important. Factory Mutual System Bulletin 8-17S, Storage of Flexible Polyurethane, provides recommendations on the height of foam piles and sprinkler installations. Information can also be found in the Uniform Fire Code, Article 81 on High Piled Combustible Storage.

*Citations*

1 *A.F. Grand, "Review and Analysis of Flammability Test Results on Upholstered Furniture Composite Mock Ups," Final Report for API by Omega Point Laboratories, Inc., September 25, 2001.*

2 *D.J. Shusterman, "Clinical Smoke Inhalation Injury: Systemic Effects," Occupational Medicine, 8(3):469-503, 1993.*

3 *M.M. Hirschler, S.M. Debanne, J.B. Larsen and G.L. Nelson, "Carbon Monoxide and Human Lethality: Fire and Non-Fire Studies," Essex, England, Elsevier Applied Science, 1993*

4 *G. L. Nelson, "Combustion Toxicity of Polyurethanes," Presentation at API Conference, 2003.*

5 *National Fire Protection Association, "Products First Ignited in U.S. Home Fires," April 2005.*

6 *Consumer Products Safety Commission, "Status Update on Regulatory Options for Upholstered Furniture Flammability." Staff Briefing, February 23, 2006.*

7 *Consumer Products Safety Commission, "2002-2004 Residential Fire Loss Estimates," July 2007.*



Center for the Polyurethanes Industry of the American Chemistry Council promotes the sustainable growth of the polyurethane industry by identifying and managing issues that could impact the industry, in cooperation with user groups. Its members are U.S. producers or distributors of chemicals and equipment used to make polyurethane or are manufacturers of polyurethane products.

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