



U.S. CONSUMER PRODUCT SAFETY COMMISSION  
WASHINGTON, DC 20207

November 2005

**CPSC STAFF RELEASE OF REVISED  
PRELIMINARY ECONOMIC REPORT ON UPHOLSTERED FURNITURE FLAMMABILITY\***

The staff of the U.S. Consumer Product Safety Commission (CPSC) is releasing a preliminary economic analysis report on upholstered furniture flammability for public review. The Commission is considering regulatory options to address the risk of residential fire associated with smoldering cigarette and small open flame ignition of upholstered furniture. The Commission published an advance notice of proposed rulemaking (ANPR) in the October 23, 2003 *Federal Register*. Pursuant to the ANPR, the CPSC staff is conducting technical and economic research to support the development of a draft flammability performance standard. In July 2005, the staff released a series of preliminary laboratory research reports. The economic report, entitled "Preliminary Regulatory Analysis of a Draft Proposed Rule to Address Cigarette and Small Open Flame Ignition of Upholstered Furniture," was prepared by CPSC's Directorate for Economic Analysis. This report was initially posted in October 2005; the revision incorporates the latest available national estimates of fire losses (i.e., deaths, injuries and property damage) associated with upholstered furniture fires.

The most recent revision of the staff's draft standard, along with a summary of the staff's technical rationale for the various elements of the standard, was presented to regulatory proceeding stakeholders at a May 18, 2005 public meeting at CPSC's Bethesda, MD headquarters. The performance and labeling / recordkeeping provisions of the draft standard were posted on the Commission's web site (please see <http://www.cpsc.gov/library/foia/foia05/brief/uphols1.pdf>). The CPSC Laboratory staff reports are posted at <http://www.cpsc.gov/library/foia/foia05/os/os.html>. The staff believes that sharing these preliminary reports at this time will maintain transparency in the regulatory development process and provide an opportunity for the staff to obtain and consider stakeholders' comments and suggestions on technical issues affecting a possible proposed rule for upholstered furniture.

For further information on this matter, contact Dale Ray, CPSC staff project manager, telephone 301-504-7704, or email [dray@cpsc.gov](mailto:dray@cpsc.gov).

\* Please note that these documents were prepared by the CPSC staff; they have not been reviewed or approved by, and do not necessarily represent the views of, the Commission.

**Preliminary Regulatory Analysis of a Draft Proposed Rule to Address  
Cigarette and Small Open Flame Ignitions of Upholstered Furniture\***

Charles L. Smith  
Directorate for Economic Analysis  
U.S. Consumer Product Safety Commission

November 2005

\* This draft analysis has been prepared by CPSC staff, has not been reviewed or approved by, and may not reflect the views of, the Commission.

## EXECUTIVE SUMMARY

In an Advance Notice of Proposed Rulemaking (published in the October 23, 2003, *Federal Register*), the U.S. Consumer Product Safety Commission (CPSC) announced its determination that ignitions of upholstered furniture by small open flames and cigarettes might constitute an unreasonable risk to the public. In response, the staff of the CPSC developed a draft standard intended to address these ignition hazards. The staff's draft proposed standard specifies tests to determine the ignition resistance of upholstery fabrics, barrier materials, and filling materials. The CPSC's Directorate for Economic Analysis has prepared a *Preliminary Regulatory Analysis of a Draft Proposed Rule to Address Cigarette and Small Open Flame Ignitions of Upholstered Furniture*. This analysis describes the businesses and products that would be affected by the staff's draft standard if it were adopted by the CPSC, the estimated societal benefits and costs that would result from compliance with the rule, and regulatory options.

The staff's draft standard would primarily affect the more than 1,600 manufacturers of residential upholstered furniture, the 100 to 200 textile manufacturers that derive a significant share of their revenues from fabric for household furniture, and the fewer than 100 manufacturers supplying polyurethane and fibrous filling materials to the furniture industry. Nearly all of the affected firms would be classified as small businesses. Several means of compliance with the draft standard would be available. Perhaps the most likely means of compliance would be the use of upholstery fabrics and covering materials that pass the draft standard's cigarette ignition test requirement combined with the use of polyurethane foam formulated with flame retardant (FR) chemicals, and the use of polyester fiber filling materials treated with FR fiber lubricants, blends of FR fibers, or encased in FR interliner fabrics. Many furniture items could comply through the use of covering materials (such as leather) that would pass the optional upholstery cover fabric barrier test. For a relatively small percent of current upholstery fabric yardage expected to fail the smoldering ignition resistance test of the draft standard, compliance could involve fabric treatment with FR chemicals, or the use of barrier materials between the fabric and filling materials.

The most recent fire loss data are from 1999 through 2002. During that time period, there were an average of about 360 deaths, 740 injuries, and \$150 million in property losses annually from fires started by either smoldering ignition sources (such as cigarettes) or small open flame ignition sources (*e.g.*, lighters, matches, and candles) in which upholstered furniture was the first item ignited. About 83 percent of these deaths, 65 percent of the injuries, and 68 percent of the property damage resulted from fires started from cigarette ignition. The remainder started from small open flames (*e.g.*, lighters, matches, candles). Laboratory test data show that furniture covered with predominantly cellulosic fabrics (*e.g.*, cotton and rayon) is much more likely to be involved in cigarette ignited fires than items covered with thermoplastic fabrics (*e.g.*,

polyester, polyolefin, and nylon); consequently, the estimated societal losses per item of furniture are much greater for items with cellulosic fabrics. Factors such as fiber content, density, and weave have been shown to make some cellulosic fabrics more likely to ignite from cigarettes than others.

Based on the 1999-2002 fire data, and estimates of the ignition propensities of upholstery fabrics, the present value of the societal costs of the furniture fires (*i.e.*, the expected costs of deaths, injuries, and property damage over the average product life of a furniture item) varies widely depending on ignition resistance of cover materials. For example, estimated societal costs are under \$20 per unit for furniture covered in thermoplastic fabrics, and about \$208 per unit for furniture items covered in highly cigarette ignition prone fabrics. (These calculations are based on 2004 dollars and assume an average product life of 15-17 years and a discount rate of 3 percent.) The expected benefits of the staff's draft standard (*i.e.*, the reduction in the societal costs associated with complying furniture) also have a wide range (*e.g.*, about \$10 per unit for furniture covered in thermoplastic fabrics and about \$166 per unit for furniture items covered in highly cigarette ignition prone fabrics). Aggregate benefits, based on the annual sales of about 31.5 million furniture items, are expected to amount to about \$936 million.

Costs of the staff's draft standard for individual items of furniture mainly depend on performance of fabrics in the fabric test of the draft standard. Approximately 10 percent of fabric yardage now used by the furniture industry may require FR treatments or the application of acceptable barrier materials beneath non-complying fabrics. The increased resource costs associated with furniture using treated FR fabrics (*i.e.*, the costs in 2004 dollars associated with materials, labor, and distribution) are expected to average almost \$15 for an average piece of furniture; the increased costs associated with the use of barriers may amount to about \$21 per unit. Furniture that will require complying cushioning materials, but not FR fabric treatments or barriers under fabrics (perhaps 60 percent of units), will incur estimated cost increases averaging under \$7 per item of furniture. Furniture covered with ignition-resistant materials that comply with the optional upholstery cover fabric barrier test (perhaps 30 percent of units) would incur small costs, mostly associated with testing and certification. Total aggregate costs of the standard for each year's production are estimated to range from about \$175 million to \$194 million, with a midpoint of \$184 million.

With estimated benefits of \$936 million over the useful lives of furniture produced in a year and a midpoint of the range of estimated annual costs of \$184 million, projected annual net benefits to society from the staff's draft proposed standard total about \$752 million. A sensitivity analysis of several factors (discount rate, value of life, injury costs, effectiveness, and costs) shows that alternative assumptions still yield substantially positive net benefits.

The *Preliminary Regulatory Analysis* also evaluates possible alternatives to the staff's draft standard, including an alternative that primarily addresses open flame ignited fires, adoption of an industry proposal as a mandatory rule; adding a small open flame ignition resistance test for cover fabrics; adopting only provisions of the draft standard relating to smoldering ignition resistance; adopting requirements of the draft standard without open flame provisions for loose filling materials; requiring product labeling that warns consumers about the flammability hazards; alternative effective dates; and the alternative of taking no regulatory action by the CPSC. The CPSC staff plans to evaluate other alternatives that may be identified during the rulemaking proceeding.

## TABLE OF CONTENTS

<b>1. INTRODUCTION</b>	<b>1</b>
<b>2. THE DRAFT STANDARD: SCOPE AND PROVISIONS</b>	<b>2</b>
<b>3. PRODUCTS AND INDUSTRIES POTENTIALLY AFFECTED</b>	<b>3</b>
<b>3.1. Upholstered Furniture</b>	<b>3</b>
<b>3.1.1. Household Upholstered Furniture Manufacturing</b>	<b>3</b>
<b>3.1.2. Household Upholstered Furniture Foreign Trade</b>	<b>4</b>
<b>3.1.3. Other Upholstered Furniture</b>	<b>5</b>
<b>3.2. Marketers of Upholstered Furniture</b>	<b>5</b>
<b>3.3. Upholstery Fabric / Materials</b>	<b>6</b>
<b>3.3.1. Textile Mills</b>	<b>7</b>
<b>3.3.2. Fabric Finishers</b>	<b>7</b>
<b>3.3.3. Upholstery Fabric Consumption by the Furniture Industry</b>	<b>7</b>
<b>3.3.4. Upholstery Fabric Foreign Trade</b>	<b>8</b>
<b>3.3.5. Characteristics of Upholstery Fabrics</b>	<b>9</b>
<b>3.3.6. Upholstered Furniture Cushioning Materials</b>	<b>10</b>
<b>4. CHARACTERISTICS OF FURNITURE IN U.S. HOUSEHOLDS</b>	<b>11</b>
<b>4.1. Numbers of Units in Use</b>	<b>11</b>
<b>4.2. Upholstery Covering Materials on Furniture in Household Use</b>	<b>12</b>
<b>5. EXPECTED BENEFITS OF THE DRAFT STANDARD</b>	<b>12</b>
<b>5.1. Expected Benefits from Reducing Cigarette Fire Losses</b>	<b>13</b>
<b>5.1.1. Societal Costs of Fires Started by Cigarettes</b>	<b>13</b>
<b>5.1.2. Expected Benefits</b>	<b>19</b>

5.2. Expected Benefits from Reducing Small Open Flame Fire Losses	24
5.2.1. Societal Costs of Small Open Flame Fires	24
5.2.2. Expected Benefits	25
6. EXPECTED COSTS OF THE DRAFT STANDARD	29
6.1. Costs Related to Upholstery Fabrics and Barrier Materials	29
6.1.1. Upholstery Fabric FR Treatments	29
6.1.2. Barrier Materials	31
6.1.3. Aggregate Costs of FR Fabric Treatments and Barriers	32
6.2. Costs Related to Urethane Foam Cushioning	33
6.2.1. Seat Cushions	34
6.2.2. Other Urethane Foam Cushioning	36
6.2.3. Summary of Costs Associated with Urethane Foam Cushioning	37
6.3. Costs Related to Fibrous Filling Materials	37
6.4. Costs Related to Compliance Verification	38
6.4.1. Costs to Industry Related to Recordkeeping	39
6.4.2. Labeling Costs	39
6.4.3. Costs to the CPSC Related to Compliance and Enforcement	40
6.5. Distribution Costs	40
6.6. Summary of Expected Costs	41
7. COMPARISON OF COSTS AND BENEFITS	42
7.1. Benefits and Costs of the Draft Proposed Standard	42
7.2. Sensitivity Analysis	44
7.3. Impact of the Draft Proposed Standard on Retail Prices	45

<b>8. ALTERNATIVES TO THE DRAFT PROPOSED STANDARD</b>	<b>46</b>
8.1. Adoption of the Draft Small Open Flame Ignition Standard	47
8.2. Adoption of Requirements Proposed by the Furniture Industry Association as a Mandatory Rule	48
8.3. Adding Open Flame Performance Testing Requirements for Upholstery Fabrics to the Draft Standard	52
8.4. Adopting Only the Requirements of the Proposed Draft Standard that Test Smoldering Ignition Performance	54
8.4.1. Costs	55
8.4.2. Benefits	55
8.4.3. Summary	56
8.5. Adopting Requirements of the Proposed Draft Standard without Open Flame Provisions for Loose Filling Materials	56
8.5.1. Costs of the Loose Fill Requirements	57
8.5.2. Benefits of the Loose Fill Requirements	57
8.5.3. Summary	58
8.6. Adoption of a Labeling Rule	59
8.7. Effective Date	59
8.8. No Action	60

# 1. INTRODUCTION

In 1993 the U.S. Consumer Product Safety Commission (CPSC) docketed a petition from the National Association of State Fire Marshals (NASFM) to initiate a rulemaking proceeding to address hazards associated with upholstered furniture fires started by small open flame ignition sources, cigarettes, and larger open-flame sources. To address hazards associated with small open-flame ignitions, NASFM sought the adoption of California's Bureau of Home Furnishings Technical Bulletin 117 as mandatory requirements for upholstered furniture sold for consumer use in the United States. Technical Bulletin 117 requires testing of the fabric and filling material components used to make furniture to increase their resistance to ignition from small open-flame and smoldering sources. NASFM's petition also sought the adoption of the California Bureau of Home Furnishings Technical Bulletin 116, and some aspects of Technical Bulletin 117, to address hazards associated with ignitions of furniture by cigarettes and other smoking materials. NASFM also asked the Commission to adopt Technical Bulletin 133, which addresses large open-flame ignition performance of furniture used in specified occupancies.

The part of NASFM's petition seeking mandatory regulation to address ignition of furniture by large open flame sources was denied by the Commission on May 12, 1994. The Commission determined that ignitions of upholstered furniture by small open flames might constitute an unreasonable risk to the public and granted that part of the petition (while reserving judgment on the technical merits of the California standard). An Advance Notice of Proposed Rulemaking (ANPR) was published in the *Federal Register* on June 15, 1994. Action on that part of the petition asking the Commission to regulate cigarette ignition hazards was initially delayed pending CPSC staff review of the effectiveness of the voluntary activities of the furniture industry.

In an ANPR published in the October 23, 2003, *Federal Register*, the U.S. Consumer Product Safety Commission (CPSC) announced its determination that ignitions of upholstered furniture by cigarettes, in addition to ignitions by small open flames, might constitute an unreasonable risk to the public, even with the presence of the voluntary industry program. The CPSC staff evaluated test requirements proposed by affected industry stakeholders, and drafted a standard that addresses both upholstered furniture ignition by cigarettes and small open flames. The provisions of this draft standard are discussed in Section 2.

This *Preliminary Regulatory Analysis* discusses the impacts of provisions specified in the CPSC staff's draft mandatory standard for addressing the cigarette and small open-flame ignition hazards presented by residential upholstered furniture. It provides information on the products and industries that are likely to be affected by actions taken to reduce upholstered furniture fires. The *Analysis* also discusses potential costs and benefits associated with requirements of that draft standard and

selected alternatives. This analysis also discusses potential effects on small firms and other market impacts.

## 2. THE DRAFT STANDARD: SCOPE AND PROVISIONS

The staff of the CPSC developed a draft standard that specifies tests to determine the ability of upholstered furniture to resist ignition when subjected to a burning cigarette or small open-flame source (*e.g.*, match, cigarette lighter, or candle).<sup>1</sup> This draft standard contains flammability performance requirements for cover fabrics and filling materials used in most residential upholstered furniture that set mass loss limits intended to prevent or slow burning behavior of materials subject to the standard. The CPSC staff's draft standard applies to finished or ready-to-assemble articles of upholstered furniture (such as upholstered sofas, loveseats, sofa beds, rockers, recliners, and other chairs) that are:

- a. primarily intended for indoor use in residences;
- b. constructed with an upholstered seating area, comprised of a contiguous upholstered seat and back and/or arm(s); and,
- c. manufactured or imported after the effective date.

The staff's draft standard offers manufacturers alternative methods to produce complying furniture. Furniture items can comply with the staff's draft standard by being made with filling materials that pass specified tests of ignition resistance and upholstery cover materials that pass the cover material cigarette ignition test (designated as "Type III upholstered furniture" in the staff's draft standard). In lieu of using complying loose filling materials, manufacturers may encase such materials with fabrics that pass optional loose filling interliner fabric ignition tests of the staff's draft standard. Alternatively, manufacturers may comply with the staff's draft standard by using a barrier material under the upholstery fabric that passes the staff's draft standard's applicable barrier tests ("Type I upholstered furniture"). This option allows manufacturers to use noncomplying upholstery fabrics and filling materials. The staff's draft standard also specifies optional performance requirements for cover materials that qualify them as barriers, which would allow the use of noncomplying filling materials ("Type II upholstered furniture"). Finally, the staff's draft standard allows manufacturers the option of qualifying combinations of upholstery materials for use in production furniture based on the results of end-product smoldering and open flame ignition resistance testing ("Type IV upholstered furniture").

---

<sup>1</sup> CPSC Staff, "Standard for Flammability of Upholstered Furniture and Upholstered Furniture Materials," May 12, 2005. (Note: Until accepted by a vote of the Commission for proposal as a mandatory standard, this is the "CPSC staff's draft proposed standard.")

### 3. PRODUCTS AND INDUSTRIES POTENTIALLY AFFECTED

#### 3.1. Upholstered Furniture

##### 3.1.1. Household Upholstered Furniture Manufacturing

The largest class of furniture products that would be affected is upholstered furniture on wood frames and dual purpose sleep furniture such as sofa beds, commonly bought for use in living rooms and family rooms. Other types of affected products include upholstered metal, reed, and rattan furniture.

Products referred to as “Household Upholstered Furniture” by the Census Bureau are classified in code 337121 of the North American Industrial Classification System (NAICS). This classification includes production of upholstered furniture on frames made of wood, metal, or other materials, as well as dual-purpose sleep furniture, such as convertible sofa beds. The 2002 *Economic Census* reports that 1,686 U.S. companies (with 1,946 establishments) manufactured upholstered household furniture or dual-purpose sleep furniture as their primary product.<sup>2</sup> Many other firms may also produce upholstered furniture as secondary products.

The *Economic Census* reports that the value of shipments of upholstered household furniture by U.S. firms in 2002 was \$10.3 billion. The *Annual Survey of Manufactures* reported shipments in 2003 of \$10.2 billion.<sup>3</sup> Domestic shipments reportedly rose 10.4 percent in 2004, according to an industry analyst.<sup>4</sup> Therefore, 2004 domestic shipments had a value of approximately \$11.3 billion.

Although there are a large number of upholstered furniture manufacturers, the top four companies accounted for nearly 32 percent of the total value of household upholstered furniture shipments in 1997 (the latest year for which industry concentration ratio data are available); the 50 largest companies accounted for about 69 percent.<sup>5</sup> Reports from the trade press indicate that the industry has become more concentrated since the 1997 Census. Several firms have ceased operations, and others have merged with larger companies through buyouts. The consolidation included Furniture Brands International’s acquisition of HDM Furniture Industries (which included Henredon and Drexel Heritage) in 2001, and La-Z-Boy’s acquisition of Ladd in January 2000 and Bauhaus and Alexvale in 1999. La-Z-Boy is the number one upholstered furniture manufacturer (by dollar volume), and Ladd, Bauhaus, and

---

<sup>2</sup> U.S. Census Bureau, U.S. Department of Commerce, 2002 Economic Census, report EC02-311-337121, “Upholstered Household Furniture Manufacturing: 2002,” September 2004.

<sup>3</sup> U.S. Census Bureau, U.S. Department of Commerce, *Value of Product Shipments: 2003, Annual Survey of Manufactures*, March 2005.

<sup>4</sup> Jerry Epperson, Mann, Armistead, and Epperson, as reporting in a column he authored in *Furniture|Today*, April 25, 2005. P. 55.

<sup>5</sup> U.S. Census Bureau, U.S. Department of Commerce, 1997 Economic Census, report EC97M31S-CR, “Concentration Ratios in Manufacturing,” June 2001.

Alexvale all previously ranked in the top 30. Furniture Brands International is the second-leading domestic manufacturer of upholstered furniture, and companies it acquired were previously part of number four-ranked LifeStyle Furnishings, International, Ltd.

The industry also includes many small companies/establishments. The 2002 *Economic Census* reports that only 29 percent of upholstered furniture establishments (564 of 1,946) had 20 or more employees, and only 10 percent (200 establishments) had 100 or more. By some measures, such as the U.S. Small Business Administration's (SBA's) definition for qualification for small business loans, a furniture manufacturing company is considered to be "small" if it has fewer than 500 employees (at all of its establishments). This definition encompassed more than 97 percent of firms in the industry in 2002.<sup>6</sup>

### 3.1.2. Household Upholstered Furniture Foreign Trade

Exports of upholstered furniture had a value of about \$242 million in 2004, or about 2 percent of the total value of shipments.<sup>7</sup> The value of imports of products categorized by the Census Bureau as NAICS 337121 was \$2,187 million in 2004.<sup>8</sup> Therefore, there were net imports of about \$1.9 billion. With estimated domestic shipments of \$11.3 billion, these net imports resulted in total apparent consumption of upholstered furniture in 2004 (domestic shipments plus imports, minus the value of exports) of about \$13.2 billion.

Imports have grown in recent years, accounting for about 17 percent of the value of total apparent consumption of residential upholstered furniture in 2004.<sup>9</sup> By way of comparison, about 9 percent of the value of apparent consumption of upholstered household furniture in 1999 was imported. The leading country of origin is China, which accounted for 39 percent of the value of imports in 2004. Italy was the second-ranking country of origin in 2004, accounting for about 22 percent of imports. Other leading sources of imported upholstered furniture in 2004 were Mexico (15 percent), and Canada (10 percent). These four countries accounted for 85 percent of the total value of imported upholstered furniture in 2004.

The importance of China as a source for imports has grown significantly in recent years. China supplanted Italy as the leading country of origin in 2004. Italy had been the number one source for upholstered furniture imports for many years. The majority of units from both China and Italy in 2004 reportedly were upholstered in

---

<sup>6</sup> Based on 2002 firm size data compiled by the United States Small Business Administration's Office of Advocacy which is available online at <http://www.sba.gov/advo/research/data.html>.

<sup>7</sup> U.S. Department of Commerce data.

<sup>8</sup> U.S. Department of Commerce and U.S. International Trade Commission data.

<sup>9</sup> Epperson, *op. cit.* estimated that 17.2% of upholstered furniture consumption was imported. Calculations above place imports at 16.6% of consumption.

leather.<sup>10</sup> Although much of the gain in China's market share has been at the expense of Italian imports, some of the furniture imported from China is from plants that have been established by several major Italian firms. China has been the leading source of wood (non-upholstered) furniture imports and its growth as a source of upholstered furniture is expected to continue. Through the first seven months of 2005, the value of Chinese imports is about 50 percent above that of the same period in 2004, according to recent trade statistics.

### 3.1.3. Other Upholstered Furniture

In addition to affecting manufacturers of residential upholstered furniture typically found in living room and family rooms, the staff's draft proposed standard also includes dining room and kitchen chairs within its scope if they are made with contiguously upholstered seats and backs. Similarly upholstered desk chairs purchased for household use are also covered by the standard. Dining chairs are generally products of firms classified in the wood household furniture industry, NAICS 337122. The *Economic Census* reports that 4.8 million wood dining room chairs were shipped in 1997, with a value of shipments totaling about \$526 million. In 2002, shipments fell to 2.9 million chairs, with a value of about \$446 million. The decline in domestic shipments is attributable to significant increases in imports of wood furniture from China and other countries. Census data are not reported separately for upholstered and non-upholstered dining chairs. In 1994, Heiden Associates surveyed participants in the voluntary industry program to improve the cigarette ignition resistance of furniture that was developed by the Upholstered Furniture Action Council (UFAC). Among the firms surveyed were manufacturers of upholstered dining room and kitchen seating. Heiden Associates estimated that the total value of shipments of such furniture that complied with the UFAC Program (and, therefore, had upholstered seats) was about \$250 million for 1993.<sup>11</sup> Based on the value of 1992 shipments (\$580 million), perhaps 3 to 4 million upholstered dining chairs were shipped by these UFAC participants. Perhaps the great majority of these items did not have upholstered backs, or they had upholstered backs that were not contiguous with upholstered seats. Other firms that are not participants in the UFAC Program also manufacture upholstered dining furniture. Given the limitations of the market data, the number of dining chairs produced annually that fall within the scope of the staff's draft proposed standard cannot be estimated with much precision, although the total number of units is thought to be relatively small.

## 3.2. Marketers of Upholstered Furniture

Annual domestic retail sales of all types of living room and family room upholstered furniture total about 30 to 33 million units with a value of over \$20 billion.

---

<sup>10</sup> Epperson, op. cit.

<sup>11</sup> Heiden Associates, Inc., "Report on Survey of UFAC Members re: Compliance with Upholstered Furniture Cigarette Ignition Flammability Standard," December 15, 1994.

Furniture manufacturers, especially smaller firms, commonly market their products through independent sales representatives who provide information on the market, and get and service new retail accounts for manufacturers. Recently, some manufacturers have reduced their reliance on independent representatives by employing their own salespeople.

Besides purchasing from manufacturers through independent sales representatives or the manufacturers' own sales staff, retailers may purchase furniture from wholesale furniture distributors. These wholesalers purchase from perhaps 25 to 30 manufacturers of different types and styles of furniture. The sales staffs of the wholesalers then call on retailers within their areas. Dealing through local wholesalers that stock an assortment of furniture, and that also offer competitive prices, credit, and other services, is advantageous to many retailers, particularly smaller firms.<sup>12</sup>

According to the 2002 *Census of Retail Trade*, 19,403 retail establishments carried upholstered furniture as a product line.<sup>13</sup> Larger retailers are more likely to purchase directly from furniture manufacturers, and smaller firms are more likely to purchase through wholesale distributors. Retail prices of upholstered furniture fall into a very broad range, depending on materials and manufacturing techniques used.

### 3.3. Upholstery Fabric / Materials

A review of trade publications and the American Textile Manufacturers Institute (ATMI) Directory of Manufacturers indicates that approximately 100 to 200 manufacturers derive a significant share of their revenues from fabric for residential upholstered furniture. This number includes textile mills that produce finished upholstery fabric and textile finishers that purchase unfinished goods and perform additional processes, such as printing and dyeing. Interior fabric revenues of the top 16 firms totaled more than \$3.5 billion in 2000, based on a survey done by *Furniture/Today*. These revenues included sales of fabrics other than those used in residential upholstery, which varied considerably, ranging from 10 percent of revenues for Quaker Fabrics to 60 percent for Covington Industries (among those firms for which sales break-outs were provided).<sup>14</sup> Based on a survey done in 1993, these firms might hold more than 80 percent of the total market for interior fabrics.<sup>15</sup> As with the upholstered furniture industry, recent years have seen consolidation of firms specializing in upholstery fabric production. Larger firms have bought out competitors or divisions of competitors, often retaining much of the existing production and management structure.<sup>16</sup>

---

<sup>12</sup> Handbook of Furniture Manufacturing & Marketing, Volume 9, Wholesaling, AKTRIN Research Institute and High Point University, May 1994.

<sup>13</sup> U.S. Census Bureau, U.S. Department of Commerce, 2002 Economic Census, report EC02-441-09 "Furniture Stores: 2002," August 2004.

<sup>14</sup> *Furniture/Today*, Cahners Publishing, Greensboro, NC, May 14, 2001, pp. 8-9.

<sup>15</sup> *Furniture/Today*, Cahners Publishing, Greensboro, NC, May 2, 1994, p. 8.

<sup>16</sup> HFN The Weekly Newspaper for the Home Furnishing Network, April 7, 1997, p. 114; and *Furniture/Today*, July 21, 1997, p. 38.

### 3.3.1. Textile Mills

Textile mills that make upholstery fabrics as their primary products are included in the North American Industry Classification System (NAICS) code 313210. Of 663 firms in NAICS 313210 in 2002, only 63 (about 10 percent) had 500 or more employees. About 65 percent of the firms had fewer than 20 employees.<sup>17</sup> The SBA considers firms with fewer than 1,000 employees to be small businesses for the purposes of programs administered by that agency. Although these data are indicative of the sizes of firms involved in the production of furniture upholstery fabrics, NAICS 313210 encompasses many firms that produce fabrics other than furniture upholstery. Nevertheless, it is likely that nearly all manufacturers of upholstery fabrics could be considered small businesses under SBA guidelines.

### 3.3.2. Fabric Finishers

Fabric finishers also tend to be small. Finishers are firms that receive unfinished fabrics (“greige goods” or “gray goods”) and perform additional manufacturing processes (*e.g.* printing, dyeing, backcoating, needle-punching, and stain-guarding). Fabrics may be purchased by the finishers, or finished under contract to other firms that supply the fabrics. Fabric finishers are classified in NAICS code 313311. Of 1,016 broadwoven fabric finishing firms in NAICS 313311 in 2002, only 30 (3 percent) had 500 or more employees.<sup>18</sup> Only a few firms currently apply FR treatments to upholstery fabrics.

### 3.3.3. Upholstery Fabric Consumption by the Furniture Industry

The U.S. Census Bureau reports that U.S. upholstery production in 2003 was 394.6 million square yards (which is the equivalent of 263 million linear yards).<sup>19</sup> The number of looms in operation for the production of these fabrics totaled 3,098 at the end of 2003. The major end-use markets for upholstery production are in upholstered furniture and automobile manufacturing. Upholstery fabrics are also used in the manufacture of window treatments and other home textiles. Based on a survey of upholstered furniture manufacturers by Ciprus, Ltd., about 233 million linear yards of upholstery fabric were consumed in the production of household furniture in 2001.<sup>20</sup> This total does not include leather and vinyl upholstery, which are estimated to have comprised about 30 percent of all furniture upholstery materials used in 2001. Therefore, total upholstery use for the domestic manufacture of residential upholstered furniture was about 333 million linear yards. Estimates of total annual upholstery

---

<sup>17</sup> Based on 2002 firm size data compiled by the United States Small Business Administration's Office of Advocacy which is available online at <http://www.sba.gov/advo/research/data.html>.

<sup>18</sup> *IBID.*

<sup>19</sup> U.S. Census Bureau. *Current Industrial Reports, Broadwoven Fabrics (Gray): 2003*. MQ313T(03)-5. May 2004.

<sup>20</sup> Ciprus Limited, LLC. *The North American Market for Contract & Residential Upholstery Fabric*, 2001.

fabric consumption based on average requirements for chairs and sofas/loveseats are 225 million linear yards.<sup>21</sup>

The U.S. Census Bureau's Economic Census report, *Upholstered Household Furniture Manufacturing: 2002*, included information on the costs of upholstery fabrics and other materials used in the production of upholstered household furniture in that year. The report placed the delivered cost of woven cotton upholstery fabrics (excluding ticking) at \$312 million and the delivered cost of other woven upholstery fabrics, such as those made of rayon, nylon, and polyester (excluding ticking) at \$802 million.<sup>22</sup> The combined total delivered cost of upholstery fabric of \$1,114 million was about 22 percent of the total delivered cost of all materials used in upholstered furniture manufacturing in 2002 (which was, according to the Census Bureau, \$5,107 million). Other upholstery cover materials include leather, which is not reported as a separate material category by the Bureau of the Census, and coated and laminated fabrics, which had a delivered cost of about \$185 million in 2002. In its 2004 Annual Report, La-Z-Boy, the largest manufacturer of upholstered furniture in the U.S. reported that purchased cover materials (primarily fabric and leather) accounted for about 43 percent of the total cost of raw materials for its upholstery group.<sup>23</sup>

#### 3.3.4. Upholstery Fabric Foreign Trade

Relatively little upholstery fabric is imported. A report by Keyser Ciprus, Ltd., estimated that 8 million linear yards of residential upholstery fabric were imported in 1997. This accounted for approximately 2 percent of total consumption of upholstery fabric for residential furniture production in that year.<sup>24</sup>

Exports of upholstery fabric are significant for many U.S. manufacturers, including Rossville/Chromatex (a division of Culp), Burlington House, Dicey Fabrics, Microfibres, and Quaker Fabrics. Rossville/Chromatex exports about 40 percent of its production, according to a 1998 article in *Textile World*. Culp is also a significant producer of flocked fabrics (second to Microfibres), which are popular in Russia and other eastern European countries. *Textile World* reported that Burlington House, believed to rank in the top five among upholstery producers, exports about 18 percent of its upholstery production. Dicey Fabrics, a smaller firm that produces a diverse product line, reportedly exports about 20 percent of its production, some of which are printed flocks for which the greige goods are purchased. Microfibres is thought to be

---

<sup>21</sup> According to industry sources, an average of approximately 7 linear yards of fabric is needed to upholster chairs and 11 to 15 yards are needed for sofas. Based on about 31.5 million annual unit shipments (of which perhaps about 53 percent are sofas, sofas, and loveseats and about 47 percent are other chairs) estimated annual upholstery material requirements are about 321 million linear yards (about 217 million yards for sofas, sofas & loveseats plus 104 million yards for chairs). About 70 percent of total yardage (about 225 million yards) would be fabrics that might require FR treatment.

<sup>22</sup> U.S. Census Bureau, *2002 Economic Census, Upholstered Household Furniture Manufacturing: 2002*, EC02-311-313311. September 2004.

<sup>23</sup> La-Z-Boy, Inc. *Annual Report for the Fiscal Year Ended April 24, 2004* (Form 10-K.) Page 4.

<sup>24</sup> Keyser Ciprus Limited, *op. cit.*, p. 40.

the world's largest manufacturer of flocked fabrics, and in the top five overall. Although exports were not reported, the popularity of these fabrics in Europe suggests that a significant percentage of Microfibres sales are exports. Another firm in the top five of fabric suppliers, Quaker Fabrics, reported that exported fabric sales totaled \$40.6 million in 2003. This accounted for 12.8 percent of gross fabric sales for the year.<sup>25</sup> Based on this information, it appears that as much as 20 percent of the upholstery fabric production by U.S. manufacturers may be exported.

There is a growing practice, especially for leather, to purchase fully cut and sewn parts from areas outside of the United States including but not limited to: Argentina, Brazil, China, Italy, Thailand and Uruguay. This trend should continue given the lower labor costs in some of these areas and other existing economic conditions. La-Z-Boy reports that importing cut and sewn leather parts results in savings of 10 to 20 percent compared to domestic purchases and fabrication of these parts.<sup>26</sup>

### 3.3.5. Characteristics of Upholstery Fabrics

CPSC-sponsored surveys of furniture manufacturers in 1981, 1984, and 1995, and commercial surveys in 1997 and 2001<sup>27</sup> provided information on two characteristics of fabrics: *fabric type* and *principal fiber (or material) type*. *Fabric Type* refers to commonly-accepted descriptions of the ways in which fabrics are manufactured or of their distinctive characteristics. For the period covered by these surveys, manufacturers increased their use of jacquards and dobbies, and decreased their use of velvets.<sup>28</sup> Usage of cotton prints and flocks fluctuated within fairly narrow ranges during the period, according to the surveys.

*Fiber (or material) Type* refers to the fibers or materials used in the manufacture of the fabrics or upholstery. Most upholstery fabric fibers are classified as *cellulosic* (e.g. cotton and rayon) or *thermoplastic* (e.g., polyester, polyolefin, and nylon); other materials used to make upholstery include vinyl (which is coated on a base fabric), wool, and leather. Based on the 2001 Ciprus Limited survey, cellulosic fabrics currently account for about 27 percent of upholstered furniture upholstery covering materials; thermoplastic fabrics account for 43 percent; leather, wool and vinyl-coated fabrics account for about 30 percent.

Review of the data on material types from the surveys conducted since 1981 indicates that the most notable changes over the years have been the increase in use of

---

<sup>25</sup> Quaker Fabric Corp. *Annual Report for the Fiscal Year Ended January 4, 2003* (Form 10-K.)

<sup>26</sup> La-Z-Boy. *op. cit.*, p. 4.

<sup>27</sup> Keyser-Ciprus, Ltd. survey (1997) and Ciprus Limited, LLC, survey (2001).

<sup>28</sup> "Jacquards" and "dobbies" refer to the types of looms and weaves used to produce fabrics. Brocades, damasks, velvets, tapestry weaves, and matelasses are often jacquard-woven. Dobbie looms enable weaving of small, geometric figures as a regular pattern. Dobby looms produce patterns that are beyond the range of simple looms, but are somewhat limited compared to a jacquard loom, which has a wider range of pattern capabilities.

leather at the expense of both cellulosic and thermoplastic fibers. The Ciprus survey in 2001 found that about 30 percent of furniture covering materials used in that year was leather, significantly greater than found in the earlier surveys.<sup>29</sup> Fabrics made from predominantly cellulosic fibers include heavier-weight fabrics (such as cellulosic jacquards and velvets) and lighter-weight fabrics (mainly cotton prints). Analysis of survey data since 1981 indicates that heavier cellulosic fabrics have usually comprised about 15 to 20 percent of all upholstery covering yardage.

### 3.3.6. Upholstered Furniture Cushioning Materials

The staff's draft standard also requires furniture manufacturers to use cushioning materials that comply with specific smoldering and open flame flammability performance requirements. As with upholstery fabric manufacturers, we expect that many manufacturers of urethane foam cushioning, polyester fiber, and cotton fiber cushioning materials would provide guaranties under the Flammable Fabrics Acts (FFA) to the furniture manufacturers that use their products. Many of these firms already test their products to market them as complying with voluntary flammability standards, and mandatory standards in effect in California and some other jurisdictions.

Based on surveys of furniture manufacturers, resilient urethane foam cushioning material is used in nearly all seat cushions, and is also a common cushioning material for furniture arms and backs. The American Furniture Manufacturers Association (AFMA) reported that an estimated 350 million pounds of urethane foam were used in furniture production in 2002.<sup>30</sup> Based on information provided by officials of major urethane foam manufacturers contacted by the Directorate for Economic Analysis, approximately 20 U.S. firms manufacture flexible urethane foam for use in upholstered furniture. These firms operate perhaps 80 to 90 plants. Based on *Census of Business* data for manufacturers of urethane foam, nearly all of these establishments would be considered small businesses.<sup>31</sup> Although about 20 firms reportedly manufacture flexible urethane foam for furniture, the top four were said to account for perhaps 60 to 65 percent of foam cushioning used by the upholstered furniture industry. These and other firms fabricate cushions that are marketed to the upholstered furniture industry. One major trade publication for the furniture industry lists 59 sources of urethane foam cushioning for furniture.<sup>32</sup> Presumably this is an extensive list of major suppliers to the industry.

---

<sup>29</sup> Ciprus Limited. *op. cit.*

<sup>30</sup> Bill Perdue, Director of Environmental and Technical Affairs, AFMA. Presentation at the Brominated Flame Retardants and Foam Furniture Conference and Roundtable. April 29 & 30, 2003. Note: the association has since changed its name to the American Home Furnishings Alliance (AHFA).

<sup>31</sup> U.S. Census Bureau, 2002 Economic Census, *Urethane and Other Foam Product (Except Polystyrene) Manufacturing: 2002*, EC02-311-326150. September 2004. (Fewer than 1 percent of the total of all establishments in the category (623) had more than 500 employees.)

<sup>32</sup> *Upholstery Design & Management (udm)*, May 2004, p.39.

The CPSC staff's draft standard also applies to manufacturers and suppliers of fibrous filling materials, such as polyester and cotton batting, and loose polyester fiberfill. A major trade publication lists about 40 suppliers of these materials to the furniture industry. Many suppliers of cotton batting also provide polyester batting and fiberfill. Some also are listed as suppliers of urethane foam cushioning. According to the *Census of Business*, 57 establishments produced "Paddings and upholstery filling, batting, and wadding" in 2002, with a value of shipments of \$490 million.<sup>33</sup> According to the Census report for upholstered furniture, the delivered cost of these materials for the production of furniture was about \$254 million. Census data indicate that nearly all suppliers of fibrous filling materials to the furniture industry are small businesses according to SBA guidelines (*i.e.*, with fewer than 500 employees).

## 4. CHARACTERISTICS OF FURNITURE IN U.S. HOUSEHOLDS

### 4.1. Numbers of Units in Use

The number of furniture units in use is estimated with the CPSC Product Population Model, based on available annual sales data and industry estimates of the average product life of furniture.<sup>34</sup> Estimates are for sofas, loveseats, armchairs, recliners, convertible sofas and other upholstered furniture commonly found in residential living rooms, family rooms, and guest rooms.

Sales are defined as shipments from U.S. manufacturers plus net imports. Annual shipment data are available from the *Economic Census* published every five years (*i.e.*, 2002, 1997, 1992, ...) by the Bureau of the Census. For upholstered wood furniture and dual-purpose sleep furniture, the *Economic Census* usually provides information on unit shipments, by type (such as sofas, sleep sofas, rockers, recliners, and other chairs). For product categories for which unit shipment data were not available, we estimated unit shipments by assigning average per unit values to the *Census* data on value of shipments. Finally, estimates of net imports were added to shipments to estimate the total number of upholstered units sold to U.S. households. For the years in which *Economic Census* data are not available, shipment estimates were based on furniture shipment values published by the Department of Commerce in the *Annual Survey of Manufactures*.<sup>35</sup>

The CPSC's Product Population Model uses sales data and information on the average product life to estimate the numbers of items remaining in use in the years following their purchase by consumers. The estimated average useful life of

---

<sup>33</sup> U.S. Census Bureau, 2002 Economic Census, *All Other Miscellaneous Textile Product Mills: 2002*, EC02-311-314999. August 2004.

<sup>34</sup> M.L. Lahr and B.B. Gordon, *Final Report on Product Life Model Feasibility and Development Study*, Battelle Columbus Laboratories, July 14, 1980.

<sup>35</sup> Estimated shipments before 1967 were based on the Federal Reserve's annual furniture production index.

upholstered furniture reportedly ranges from 15 to 17 years.<sup>36</sup> Based on the assumption that the expected life of a piece of upholstered furniture is 16 years, the average number of upholstered items in household use during 1999-2002 was about 440 million pieces.

## 4.2. Upholstery Covering Materials on Furniture in Household Use

Surveys of furniture manufacturers in the last several years show the shift towards thermoplastic fabrics peaked during the period of the mid-1980's to the mid-1990's. Information provided to the CPSC by the Upholstered Furniture Action Council (UFAC) showed that a significant shift to greater use of thermoplastic fabrics began in the 1950's, and became more pronounced in the 1970's.<sup>37</sup> These data on usage of different types of fabrics over the years can be used to characterize upholstery fabrics found on furniture in U.S. households. An estimated 32.9 percent of furniture in use in U.S. households during the period 1999-2002 was covered with fabrics predominantly made with cellulosic fabrics; an estimated 51.2 percent were covered with predominantly thermoplastic fabrics, and 15.8 percent were covered with other materials (mainly leather, wool, and vinyl-coated fabrics).

## 5. EXPECTED BENEFITS OF THE DRAFT STANDARD

The expected benefits of the CPSC staff's draft proposed standard are estimated as the reduction in the societal costs associated with upholstered furniture fires that would be prevented by the standard. We estimate the benefits in several steps. First, we estimate the average annual societal costs of upholstered furniture fires, based on estimates of the aggregate annual costs of fire-related deaths, injuries, and property damage. These costs are differentiated by ignition source (*i.e.*, cigarette *vs.* open flame ignition) and by fabric covering type (since different fabrics exhibit different ignition propensities). Societal costs are also estimated on a "per product in use" basis, based on estimates of the numbers of furniture items in use.

Second, since each furniture item is expected to remain in use for an average of 15 to 17 years, the present value of the product's estimated lifetime fire costs is estimated by summing the discounted annual costs over the item's expected useful life. The estimated annual costs that are expected to accrue over the furniture item's useful life are discounted at an annual rate of 3 percent. This rate is consistent with recommendations in the economic literature for discounting the costs and consequences of health programs.<sup>38</sup> (However, a sensitivity analysis is also conducted in Section 8 to show how a 7 percent discount rate would impact on the results of the analysis.)

---

<sup>36</sup> Based on discussions between industry officials and Department of Commerce personnel.

<sup>37</sup> Report to the CPSC on the UFAC Voluntary Program, Upholstered Furniture Action Council, March 21, 1978.

<sup>38</sup> For example: Viscusi, W.K., "Discounting Health Effects for Medical Decisions," in *Valuing Health Care: Costs, Benefits, and Effectiveness of Pharmaceuticals and Medical Technologies*, ed. F.A. Sloan, 123-24. New York: Cambridge University Press. 1995. Also, Gold, Marthe R., *et. al.*, *Cost-Effectiveness in Health and Medicine*. New

Third, the expected effectiveness of the staff's draft proposed standard (*i.e.*, the percentage reduction in fire losses) is estimated for each ignition source and upholstery cover type. As discussed below, effectiveness of the standard at reducing societal costs is based on judgments regarding improvements attributed to fabric treatments and effectiveness of barrier materials, and the contribution made by improved ignition performance of filling materials that comply with the smoldering and open flame material tests.

We begin the analysis in Section 5.1 by evaluating the societal costs of cigarette fires and the expected benefits associated with preventing these fires. This is followed in Section 5.2 with an evaluation of the societal costs and likely benefits associated with the prevention of open-flame ignited fires.

## **5.1. Expected Benefits from Reducing Cigarette Fire Losses**

### **5.1.1. Societal Costs of Furniture Fires Started by Cigarettes**

The purpose of this section is to estimate the societal costs of cigarette-related upholstered furniture fires to use as the basis for estimating the cigarette benefits. In the next section (5.1.2.), benefits are estimated as avoided societal costs. These costs are based on fire losses (deaths, injuries and property loss) estimated by the CPSC Directorate for Epidemiology, which relies on fire loss data acquired from the National Fire Protection (NFPA) annual survey of fire departments and the U.S. Fire Administration (USFA) National Fire Incident Reporting System (NFIRS). The most recent fire data available to make such estimates was for the 1999-2002 time period. Societal cost estimates are also differentiated by fabric cover types, which (as described below) exhibit different cigarette ignition propensities.

According to the CPSC's Directorate for Epidemiology, there was an average of 300 addressable civilian deaths and 480 nonfatal civilian injuries annually from fires started by cigarettes during the 1999-2002 time frame.<sup>39</sup> There was also an average of about \$102 million annually (in constant 2004 dollars) in property losses from cigarette-ignited fires.<sup>40</sup> By combining the costs associated with deaths, injuries, and property damage total societal costs can be estimated.

---

York: Oxford University Press. 1996.

<sup>39</sup> Levenson, Mark S., "Upholstered Furniture Addressable Fire Loss Estimates for 1999-2002," Directorate for Epidemiology, U.S. Consumer Product Safety Commission, November 21, 2005. The Directorate for Epidemiology based its estimates on a methodology that was refined to address concerns raised by the General Accounting Office (GAO) in a 1999 report, "Consumer Product Safety Commission: Additional Steps Needed to Assess Fire Hazards of Upholstered Furniture."

<sup>40</sup> Estimated average property losses of about \$90 million for 1999-2002 (Levenson, *op. cit.*) are expressed in 2004 dollars (\$108 million) based on changes in the Producer Price Index for construction materials.

For analytic purposes staff assigns a value of \$5 million as the value of a statistical life for the calculation of societal costs. The \$5 million estimate is consistent with the general range of the value of a statistical life published in the literature, which generally falls in the \$3 million to \$7 million range.<sup>41</sup> Multiplying the annual estimate of about 300 deaths by the value of a statistical life of \$5 million yields annual fatality costs of \$1.5 billion.

Nonfatal injuries were assigned an average cost of \$187,449 each. The basis for this estimate was the analysis of burn injury costs reported in the August 1993 report "Societal Costs of Cigarette Fires," part of the research sponsored by the CPSC under the Fire Safe Cigarette Act of 1990.<sup>42, 43</sup> The \$187,449 figure represents a weighted average of injury costs (including pain and suffering) for both hospitalized injuries and injuries treated and released. The estimate of 480 injuries annually results in societal costs of about \$90 million.

As noted above, the staff's draft standard would also address about \$102 million annually in property losses from fires started by cigarettes, based on estimates for the 1999-2002 period. Consequently, the total annual costs of cigarette-ignited fires addressed by the draft standard amounted to an annual average of about \$1,692 million (\$1,500 million + \$90 million + \$102 million) during the 1999-2002 time period.

Information on the number of furniture items (*i.e.*, separate pieces of furniture) in use provides a basis for estimating the costs of cigarette ignition fires on a per unit basis. As noted in Section 4.1, the average estimated number of items of residential living room and family room upholstered furniture in use during the 1999-2002 time period was about 441 million units, based on an expected useful product life of 15-17 years. Given the annual societal costs and the number of furniture units in use, the annual societal cost per unit of furniture in use, resulting from cigarette ignition, amounted to about \$3.83 (\$1,692 million / 441 million units of furniture). This per unit societal cost estimate represents an average across all furniture items in use. However, because different fabric coverings for furniture exhibit different ignition propensities, we can develop more precise estimates of per unit societal costs by accounting for the fabric cover.

Ignition testing of chairs by CPSC staff and others over the years has shown that the cigarette ignition hazard of furniture mainly involves chairs covered with fabrics that are predominantly woven from cellulosic fibers, *i.e.*, cotton and rayon. Chair testing done by the CPSC staff and California's Bureau of Home Furnishings has shown

---

<sup>41</sup> Viscusi, W. Kip, "The Value of Risks to Life and Health," *Journal of Economic Literature*, Vol. XXXI, December 1993, pp. 1912-1946.

<sup>42</sup> Zamula, William W., "Costs for Non-Fatal, Addressable Residential Civilian Injuries Associated with Upholstered Furniture Fires." (Memorandum to Gregory B. Rodgers, AED, EC) Directorate for Economic Analysis, U.S. Consumer Product Safety Commission. November 22, 2005. (Costs are estimated in 2004 dollars.)

<sup>43</sup> Miller, Ted R., *et. al.*, "Societal Costs of Cigarettes Fires," prepared for the U.S. Consumer Product Safety Commission under the Cigarette Safety Act of 1984, August 1993.

that chairs covered with predominantly thermoplastic fabrics (e.g., polyester, polypropylene, and nylon) are much less likely to ignite from cigarettes. Chairs covered with some materials, such as leather, vinyl-coated fabrics, and wool fabrics are resistant to ignition from cigarettes. Given the disparity of ignition propensities, some types of furniture would be expected to result in greater societal costs from fires. Information relevant to the determination of average ignitability and estimation of societal costs for furniture covered with different types of materials is discussed below.

The results of the analysis described in this section (including estimates of market shares by fabric covering, estimates of ignition propensities and risk by fabric type, and estimates of annual societal costs) are summarized in Table 1.

### *Estimated Market Shares, by Type of Upholstery Covering*

Estimates of the types of upholstery on furniture pieces found in households during 1999-2002 were derived from historical data from surveys in various years, estimates of annual sales of upholstered furniture, and calculations of the survival of furniture in years after purchase (using the CPSC's Product Population Model). Based on these sources, the Directorate for Economic Analysis estimates that 51.2 percent of the 441 million upholstered furniture items that were in use during 1999-2002 were covered with thermoplastic fabrics, 32.9 percent were covered with cellulosic fabrics, and 15.8 percent were covered with leather, vinyl-coated fabrics, or wool fabrics. These market shares are shown in Table 1, column 1.

Note that the market shares in the first three rows sum to the 32.9 percent of the furniture in use covered with cellulosic fabrics. However, because extensive testing data show that some cellulosic fabrics are more likely to ignite than others, this analysis also separates cellulosic fabrics into three categories according to their ignition propensities. The next several paragraphs describe this sub-categorization of cellulosic fabric coverings.

Testing by the CPSC laboratory using the draft *Upholstery Fabric Smoldering Ignition Test*<sup>44</sup> indicates that upholstery cover materials which are most likely to fail the test are fabrics woven entirely of cellulosic fibers that are heavier than eight ounces per square yard. These fabrics are assumed to include all fabrics that would be classified as Class II fabrics under the UFAC Program as well as predominantly cellulosic fabrics that would be classified as Class I fabrics under the UFAC Program and Class D fabrics according to the draft furniture flammability standard fabric test method developed by the National Bureau of Standards (NBS, now the National Institute of Standards and Technology) in the 1970's. Estimation of the percentage of fabrics that would fail the fabric test of the CPSC staff's draft standard, and assessment of the societal costs

---

<sup>44</sup> The *Upholstery Fabric Smoldering Ignition Test* is cigarette ignition testing of fabrics over a standard flame-retardant polyurethane foam substrate.

presented by different types of upholstery cover materials are, therefore, based on fabric and chair test data accumulated over the years.

Classification of cellulosic fabrics according to the test developed by UFAC (which classifies fabrics according to char length on the vertical surface when tested over standard non-FR polyurethane foam) and the test developed by NBS (which classifies fabrics according to char length when tested over a glass fiberboard substrate) have been used to categorize the ignition performance of cellulosic fabrics in this analysis. CPSC laboratory analyses since 1980 found that about 82 percent of cellulosic fabrics tested were Class I fabrics according to the fabric classification test of the UFAC Program (*i.e.*, having a vertical char length of less than 1.75 inches), and 18 percent of cellulosic fabrics were UFAC Class II fabrics (*i.e.*, having a vertical char length of 1.75 inches or greater). Assuming the tested fabrics were representative of cellulosic fabrics, 27.0 percent of all fabrics on furniture in use during 1999-2002 were UFAC Class I (32.9% that were covered with cellulosic fabrics x 82%) and 5.9 percent were UFAC Class II (32.9% x 18%).

Laboratory testing shows that the *Upholstery Fabric Smoldering Ignition Test* of the staff's draft proposed standard is slightly more severe than the UFAC Fabric Classification Test.<sup>45</sup> Therefore, for the purposes of this analysis, UFAC Class II fabrics are assumed to fail the draft fabric test without changes that would improve their ignition resistance. Limited testing also indicates that some portion of UFAC Class I fabrics will fail the fabric test of the staff's draft standard. Twenty-five percent of the Class I fabrics tested by the CPSC staff in 1980 and 1984 were found to be generally more ignition-prone Class D fabrics according to the NBS fabric classification test (*i.e.*, sustaining chars of greater than 3 inches when tested over glass fiberboard). If we assume that such fabrics would fail the draft standard's fabric test, approximately 12.7 percent of fabrics found on furniture in 1999-2002 would have failed the test (5.9 percent which were UFAC Class II, plus 25 percent of the 27.0 percent of other cellulosic fabrics which were UFAC Class I. (Designated as "Severely Ignition-Prone Cellulosics" in Table 1.)

Fabrics assumed to pass the staff's draft standard include more moderately ignition-prone fabrics that are Class I according to the UFAC Fabric Classification test and Class C according to the NBS fabric test (*i.e.*, sustaining chars of 1.5 - 3 inches when tested over glass fiberboard), and more ignition-resistant Class B cellulosic fabrics according to the NBS fabric test (which sustain char lengths of less than 1.5 inches when tested over glass fiberboard). The Class C fabrics accounted for an estimated 6.1 percent of fabrics found on furniture in 1999-2002 (22.5 percent of UFAC Class I cellulosic fabrics according to CPSC staff testing). These fabrics are designated as "Moderately Ignition-Prone Cellulosics" in Table 1. More ignition-resistant NBS Class B

---

<sup>45</sup> Tao, Weiyang, Ph.D. "Evaluation of Test Method and Performance Criteria for Cigarette Ignition (Smoldering) Resistance of Upholstered Furniture Materials." Division of Electrical and Flammability Engineering, Directorate for Laboratory Sciences, U.S. Consumer Product Safety Commission. May 2005.

fabrics are estimated to have comprised 52.5 percent of UFAC Class I cellulosic fabrics, or 14.2 percent of all fabrics and covering materials found on upholstered items in 1999-2002. These fabrics are designated as "Less Ignition-Prone Cellulosics" in Table 1.

### *Estimated Ignition Propensities*

Estimated ignition propensities for furniture covered with cellulosic fabrics are based on chair testing that was done in 1984 and 1994. Evaluating chair test results according to UFAC and NBS fabric classifications, 58.3 percent of test cigarettes were estimated to lead to ignitions for chairs covered with UFAC Class II fabrics. The estimated ignition propensity for test cigarettes on chairs covered with UFAC Class I, NBS Class D fabrics was 46.6 percent. Combining these two severely-ignition-prone fabric classes yields an average estimated ignition propensity of 52.1 percent (weighted by their 1999-2002 market shares). Cigarettes placed on furniture covered with moderately ignition-prone fabrics had an estimated 32.2 percent likelihood of resulting in ignition.<sup>46</sup> About 10.5 percent of test cigarettes were estimated to lead to ignitions for chairs covered with less ignition-prone cellulosic fabrics.<sup>47</sup> (See column 2 of Table 1.)

Because of less concern with the ignition propensity of thermoplastic fabrics, ignition testing data for such materials are more limited. Expanding chair test data to include tests conducted in 1980 led to an estimate that 1.5 percent of test cigarettes would result in ignition for furniture covered with thermoplastic fabrics. Additionally, based on limited laboratory ignition testing data, materials such as leather, wool fabrics, and vinyl-coated fabrics are assumed to be highly resistant to ignition from cigarettes.

### *Weighted Ignition Propensities*

The calculation of weighted ignition propensities of furniture covered with different types of fabrics is the product of the estimated market share of furniture in use in 1999-2002 for each type of fabric and its estimated ignition propensity. The estimated weighted ignition propensity was .066 for items covered with severely ignition-prone cellulosic fabrics (*i.e.*, 12.7% share of the market x 52.1% ignition propensity); .020 for items covered with moderately ignition-prone cellulosic fabrics (6.1% x 32.2%); .015 for items covered with less ignition-prone cellulosic fabrics (14.2% x 10.5%); and .008 for items covered with thermoplastic fabrics (51.2% x 1.5%). (See column 3 of Table 1.)

### *Percent of Total Risk, by Fabric Type*

The percent of total risk presented by furniture covered with different fabric types was derived by dividing estimated weighted ignition propensities by the sum of all weighted ignition propensities (which was about .108 for furniture in use in 1999-

---

<sup>46</sup> UFAC Class I, NBS Class C cellulosic fabrics.

<sup>47</sup> NBS Class B cellulosic fabrics.

2002). Thus, as shown in the table, the more severely ignition-prone cellulosic fabrics<sup>48</sup> were estimated to account for 61.0 percent of the total risk (.066/ .108); moderately ignition-prone cellulosic fabrics<sup>49</sup> accounted for about 18.1 percent of the risk (.020/ .108); less ignition-prone cellulosic fabrics accounted for about 13.8 percent of the risk (.015/ .108); and thermoplastic fabrics accounted for about 7.1 percent of the risk (.008/ .108). (See column 4 of Table 1.<sup>50</sup>)

### *Average Annual Societal Costs of Cigarette Ignition, by Fabric Type and Ignition Propensity*

The average annual societal costs associated with cigarette ignitions of each fabric type were estimated by dividing the product of estimated percent of total risk (above) and the total estimated average annual societal costs associated with cigarette ignition of furniture (\$1,692 million) by the estimated number of units in use during 1999-2002 with each fabric type (441.4 million units in use x estimated market share). The average annual societal costs were estimated to be \$18.45 for items covered with severely ignition-prone cellulosic fabrics (61.0% x \$1,692 million / 441.4 million x 12.7%); \$11.41 for items covered with moderately ignition-prone cellulosic fabrics (18.1% x \$1,692 million / 441.4 million x 6.1%); \$3.72 for items covered with less ignition-prone cellulosic fabrics (13.8% x \$1,692 million / 441.4 million x 13.8%); and \$.53 for items covered with thermoplastic fabrics (7.1% x \$1,692 million / 441.4 million x 51.2%). (See column 5 of the Table 1.)

### *Lifetime Societal Costs of Cigarette Ignition, by Fabric Type*

The estimated lifetime societal costs per unit of furniture were calculated as the present value of the estimated annual societal costs over the expected product life of the item of furniture. The annual expected societal costs of cigarette ignition were assumed to apply each year that an item of furniture remains in household use. The CPSC's Product Population Model was used to calculate the likelihood that furniture items would remain in use in years after purchase. Annual societal costs per unit were multiplied by estimated probability of survival in subsequent years. The estimated stream of future expected societal costs were discounted to their present values, using a discount rate of 3 percent.

### *Adjustments for Changes in Smoking Behavior and Other Factors*

Available data suggest that other factors (in addition to changes in fabrics) have contributed to a decline in fires resulting from cigarette ignition of upholstered furniture over time. These factors include changes in smoking-related behavior of

---

<sup>48</sup> UFAC Class II and UFAC Class I/NBS Class D fabrics.

<sup>49</sup> NBS Class C cellulosic fabrics.

<sup>50</sup> Percent of total risk for each fabric type was calculated from estimates of market share and ignition propensity that were not rounded.

individuals, increased presence of smoke alarms, and changes in furniture filling materials. The present value estimates were further adjusted to account for an expected future decline in smoking-related fire incidents. This was done by forecasting future fire deaths by year, based on trends during 1980-1998, and reducing the expected societal costs of cigarette ignited fires by the projected percentage reduction. This analysis found that expected lifetime societal costs, discounted to their present value using a 3 percent discount rate, should be reduced by approximately 13 percent. Thus, expected lifetime societal costs per unit of \$224.12 for items covered with severely ignition-prone cellulosic fabrics were reduced to \$194.76 after incorporating the trend data. Similar calculations led to estimates of lifetime societal costs of \$120.44 for items covered with moderately ignition-prone cellulosic fabrics; \$39.28 for items covered with less ignition-prone cellulosic fabrics; and \$5.62 for items covered with thermoplastic fabrics. (See column 6 in Table 1.)

### **5.1.2. Expected Benefits**

The purpose of this section is to estimate the expected benefits of preventing cigarette ignition fires (i.e., the reduction in societal costs that will result), based on the societal cost estimates derived in Table 1.

The analysis described in Section 5.1.1. estimated the per unit hazard costs associated with the upholstery materials of different ignition propensities, based on the furniture in use during 1999-2002, the most recent time period for which fire data is available. However, as discussed in Section 4, the types of upholstery materials used in the production of furniture has changed over the years. Since the staff's draft standard would address risks associated with current production, projection of benefits requires estimating the societal costs associated with materials now being used to manufacture furniture. This is accomplished by estimating the percentage of furniture items currently made with covering materials of differing ignition propensities.

**Table 1.**

**Estimated Societal Costs of Cigarette Ignition of Upholstered Furniture, by Ignition Propensity of Cover Materials, for Furniture in Use During 1999-2002 (in 2004 dollars)**

Type of Upholstery Cover Material	(1) % of Furniture in Use, 1999-2002	(2) Ignition Propensity	(3) Weighted Ignition Propensity (1) × (2)	(4) % of Overall Risk <sup>4</sup>	(5) Annual Societal Costs per Unit	(6) Lifetime Societal Costs per Unit, Adjusted <sup>5</sup>
Severely Ignition-Prone Cellulosics <sup>1</sup>	12.7%	.521	.066	61.0%	\$18.45	\$194.76
Moderately-Ignition-Prone Cellulosics <sup>2</sup>	6.1%	.322	.020	18.1%	\$11.41	\$120.44
Less Ignition-Prone Cellulosics <sup>3</sup>	14.2%	.105	.015	13.8%	\$3.72	\$39.28
Thermoplastics	51.2%	.015	.008	7.1%	\$0.53	\$5.62
Leather, wool, vinyl-coated	15.8%	See note <sup>6</sup>	See note <sup>6</sup>	See note <sup>6</sup>	See note <sup>6</sup>	See note <sup>6</sup>

<sup>1</sup> UFAC Class II (5.9% of fabrics) and Cellulosic UFAC Class I/NBS Class D Fabrics (6.8% of fabrics).

<sup>2</sup> UFAC Class I/NBS Class C Cellulosic Fabrics.

<sup>3</sup> Predominantly Cellulosic Class B Fabrics according to the NBS draft standard.

<sup>4</sup> The Percent of Overall Risk for each type of upholstery cover material (column 4) is calculated by dividing weighted ignition propensity (column 3) by the summation of the weighted ignition propensities (0.108).

<sup>5</sup> Based on a 3% discount.

<sup>6</sup> Based on limited laboratory testing data, leather, wool, and vinyl-coated fabrics are assumed to be highly resistant to ignition from cigarettes. Therefore, ignition propensity of these materials is small, but unknown, as are the annual and lifetime societal costs per unit covered with these materials.

A 2001 survey of furniture manufacturers by Ciprus Limited provides information on consumption of cellulosic, thermoplastic, and leather covering materials in the production of furniture.<sup>51</sup> Using CPSC staff test data discussed above, the percentages of current production (as indicated by the Ciprus data) made with materials ranging from severely ignition-prone cellulosic fabrics to ignition resistant materials such as leather were estimated. These estimates are shown in column 1 of Table 2 below. The estimated percentage of upholstered items now made with severely ignition-prone cellulosic fabrics has fallen to 10.3 percent of annual production, from 12.7 percent estimated for furniture in use during 1999-2002. This is a nearly 19 percent decrease in the relative use of the most ignition-prone class of fabrics. The use of other ignition-prone fabrics has also declined, in relative terms, while the use of generally ignition-resistant materials such as leather (estimated to be about 30 percent of current production) is 91 percent greater than found in household use in 1999-2002.

Column 2 of Table 2 shows the expected number of furniture units produced annually, by type of covering material, based on the market shares of the various fabric coverings (column 1) and an estimated 31.5 million furniture units produced. Column 3 provides the estimates of per unit lifetime societal costs derived in Table 1.

Based on current estimates of the types and quantity of furniture produced, the estimated total present value of the expected societal costs from cigarette fires is \$1,039.9 million for furniture produced in a year, in the absence of a standard. (See column 4 of Table 2.) Total estimated societal costs involving furniture covered with severely ignition-prone cellulosic fabrics account for \$633 million, or about 61 percent of the total. In contrast, thermoplastic fabrics, which are used to cover about 43 percent of all upholstered furniture produced, account for an estimated \$76.1 million in societal costs, or only about 7 percent of the total.

### *Estimated Effectiveness of the Draft Standard*

A comparison of the ignition performance of upholstered chairs made with current fabrics and filling materials with that of chairs made in compliance with the staff's draft standard would provide data to assess the likely reduction in ignition propensity that would result from the draft standard. In the absence of such data, we can estimate the benefits of the standard by making reasonable judgments about improvements in ignition performance that would result from the use of complying materials.

We assume that furniture currently manufactured with severely ignition-prone cellulosic fabrics would realize a reduction in societal costs per unit under the staff's draft standard to the equivalent of that now estimated for furniture covered by less ignition-prone cellulosic fabrics. This reduction would be attributable to improved

---

<sup>51</sup> Ciprus Limited, *op. cit.*

ignition performance of FR-treated fabrics and improved ignition performance of filling materials, or from the use of qualifying barriers. The reduction in lifetime societal costs per unit from \$194.76 to \$39.28 amounts to a hazard reduction of 79.8 percent (shown in column 5 of Table 2). We likewise assume that pre-standard societal costs estimated for moderately ignition-prone cellulosic fabrics also would fall to the estimated hazard costs associated with furniture covered with less ignition-prone fabrics. The estimated reduction from estimated lifetime societal costs of \$120.44 to \$39.28 would be a 67.4 percent reduction in the hazard presented (also shown in column 5). For the purposes of this analysis, we estimate that upholstered furniture items covered with less ignition-prone cellulosic fabrics and thermoplastic fabrics would also realize a 67.4 percent reduction in their expected societal costs. The reduction in the hazard is expected to result from smoldering ignition requirements for filling materials when tested with a standard cover fabric. The staff's draft standard requires that materials that are tested shall not have less than 90 percent non-smolder residue of the substrate or filling material at 30 minutes when tested in accordance with the appropriate test method. Materials that comply with the smoldering tests should present a much lower likelihood that smoldering ignitions would progress to hazardous conditions.

The estimated benefits per unit were calculated for each fabric class. (See column 6 of Table 2.) Per unit benefits of the staff's draft standard range from \$3.78 for furniture covered with relatively ignition-resistant thermoplastic fabrics to an estimated \$155.48 per unit for items currently covered by severely ignition-prone cellulosic fabrics. The benefits, from ignition resistant materials such as leather, wool, and vinyl-coated fabrics are unknown, but are expected to be small.

The total estimated benefits of the staff's draft standard are calculated by multiplying estimated per unit benefits (shown in column 6) by the estimated annual units produced with each class of covering material (column 2). Based on these calculations, estimated benefits of the standard, in the form of expected lifetime reduction in societal costs associated with production of furniture in one year, total \$779.2 million. About 65 percent of total estimated benefits are associated with the approximately 10 percent of furniture currently made with severely ignition-prone cellulosic fabrics.

**Table 2.**

**Cigarette Ignition Societal Costs and Estimated Benefits from Furniture Produced in a Year (*in 2004 dollars*)**

Type of Upholstery Cover Material	(1) % of Annual Production	(2) Annual Units Produced	(3) Lifetime Societal Costs per Unit, Adjusted <sup>1</sup>  (Table 1)	(4) Total Estimated Societal Costs <sup>2</sup> (million \$)  (2) x (3)	(5) Estimated Hazard Reduction	(6) Estimated Benefits per Unit  (3) x (5)	(7) Total Estimated Benefits (million \$)  (2) x (6)
Severely Ignition-Prone Cellulosics	10.32%	3,250,306	\$194.76	\$633.0	79.8%	\$155.48	\$505.4
Moderately-Ignition-Prone Cellulosics	4.94%	1,557,614	\$120.44	\$187.6	67.4%	\$81.16	\$126.4
Lower Ignition-Prone Cellulosics	11.54%	3,634,433	\$39.28	\$142.7	67.4%	\$26.47	\$96.2
Thermoplastics	42.96%	13,532,327	\$5.62	\$76.0	67.4%	\$3.78	\$51.2
Leather, wool, vinyl-coated	30.24%	9,525,321	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>
All Covering Materials	100.0%	31,500,000	\$43.89	\$1,039.4	--	\$31.97	\$779.2

<sup>1</sup> Based on a 3% discount rate.

<sup>2</sup> Based on estimated annual production of 31.5 million pieces of upholstered furniture for household consumption.

<sup>3</sup> Based on limited testing data, leather, wool, and vinyl-coated fabrics are assumed to be highly resistant to ignition from cigarettes. Therefore, the societal costs (and, hence, the potential benefits) associated with these covering materials are small but unknown.

## 5.2. Expected Benefits from Reducing Small Open Flame Fire Losses

### 5.2.1. Societal Costs of Small Open-Flame Fires

In addition to cigarette losses, the Directorate for Epidemiology estimated open-flame ignitions for the years 1999-2002.<sup>52</sup> During this time period, there were an average of 60 deaths and 260 nonfatal injuries annually from fires started by small open flames. There was also an average of about \$48 million annually in property losses from small open flame-ignited fires during this time frame.<sup>53</sup>

Assuming a value of statistical life of \$5 million,<sup>54</sup> the societal costs associated with the 60 deaths annually amounted to about \$300 million. The 260 nonfatal injuries were assigned an average cost of \$187,449 each,<sup>55</sup> resulting in societal costs of about \$49 million. Adding in the \$48 million annually in property losses from fires started from small open-flame ignition, the total annual costs of open-flame ignited fires addressed by the staff's draft standard amount to about \$397 million (\$300 million + \$49 million + \$48 million).

As in Table 1, these annual estimates of the open-flame losses are used to develop estimates of the lifetime societal costs of open-flame hazards per unit of furniture in use during the 1999-2002, for each of the five fabric categories. The results are presented in Table 3.

Column 1 of Table 3 shows the proportions of furniture in each fabric material category, and is identical to the corresponding column in Table 1. Column 2 describes open-flame ignition propensities, based on small open flame ignition testing by the CPSC laboratory in 1996. In that testing, cellulosic and thermoplastic fabrics had nearly the same ignition propensity when subjected to a small flame for 20 seconds. Ignitions in 20 seconds or less were observed for 27 of 29 predominantly cellulosic fabrics (about 93 percent) and 17 of 18 predominantly thermoplastic fabrics (about 94 percent).<sup>56</sup>

Based on these ignition propensities and the estimated percentages of furniture in use comprised by upholstered items with cellulosic and thermoplastic fabrics, furniture covered with thermoplastic fabrics accounted for an estimated 61.2 percent of the overall risk of small open flame ignitions during 1999-2002; items covered with cellulosic fabrics accounted for about 38.8 percent of the risk. While Table 3 separates cellulosic fabrics according to differences in their cigarette ignition propensities, for this

---

<sup>52</sup> Levenson, Mark S. *op.cit.*

<sup>53</sup> Estimated average property losses for 1999-2002 are expressed in 2004 dollars, based on changes in the Producer Price Index for construction materials.

<sup>54</sup> Viscusi, W. Kip, *op. cit.*

<sup>55</sup> Zamula, William W., *op. cit.* Injury costs are expressed in 2004 dollars.

<sup>56</sup> Directorate for Laboratory Sciences memoranda dated October 3, 1996, through September 19, 1997, Attachment B, "Regulatory Options Briefing Package on Upholstered Furniture Flammability," October 28, 1997.

analysis all cellulosic fabrics are assumed to have the same small open flame ignition propensity. The estimated percent of overall risk for each type of cellulosic fabric is, therefore, determined by market share. As with the risk of ignition by cigarettes, furniture covered by leather, wool, and vinyl-coated fabrics is assumed to be resistant to ignition from a 20-second exposure to a small open flame.

Following the same methodology described in Table 1, the average annual societal costs associated with small open flame ignitions of each fabric type were estimated by dividing the products of estimated percent of total risk and the total estimated average annual societal costs associated with small open flame ignition of furniture (\$397 million) by the estimated number of units in use during 1999-2002 with each fabric type (441.4 million units in use x estimated market share). This approach resulted in estimated average annual societal costs of about \$1.07 for items covered with thermoplastic fabrics (61.2% x \$397 million/441.4 million x 51.2%) and about \$1.06 for items covered with predominantly cellulosic fabrics (38.8% x \$397 million/441.4 million x 32.9%). (See column 5 of Table 3.)

Finally, the lifetime societal costs (per unit of furniture) were estimated as the present value of the annual per unit societal costs over the expected product life of a furniture item. This present value estimate (shown in column 6), discounted at a rate of 3 percent, is about \$13.05 for items covered with predominantly thermoplastic fabrics and \$12.86 for items covered with predominantly cellulosic fabrics.

### 5.2.2. Expected Benefits

The estimated benefits associated with the prevention of open-flame fires are described in Table 4. The methodology is similar to that described for Table 2. Column 1 shows the current market shares, by fabric type, and Column 2 shows annual sales based on annual furniture shipments of 31.5 million units. Column 3 provides the estimates of per unit lifetime societal costs derived in Table 3, and Column 4 provides estimates of the aggregate societal costs of fires associated with open-flame ignition.

For the purposes of this analysis, it is assumed that 60 percent of furniture currently manufactured with severely cigarette ignition-prone cellulosic fabrics (accounting for 6.2 percent of all furniture items) would be made with fabrics treated with FR chemicals to enable them to pass the upholstery cover fabric smoldering ignition resistance test (but not the upholstery fabric fire barrier open flame ignition resistance test). In 2001 the CPSC staff estimated that FR treatment of fabrics to achieve compliance with a draft small open flame standard might result in an 88 percent reduction in small open flame fire losses.<sup>57</sup> Since FR fabric treatments under the current standard drafted by the CPSC staff would specifically address cigarette ignition performance of fabrics, their effectiveness at reducing the small open flame fire hazard

---

<sup>57</sup> Smith, Charles, Directorate for Economic Analysis, CPSC, *Economic Analysis of Regulatory Options to Address Small Open Flame Ignitions of Upholstered Furniture*, October 2001.

**Table 3.**

**Estimated Societal Costs from Small Open Flame Ignition of Upholstered Furniture for Furniture in Use During 1999-2002**  
(in 2004 dollars)

Type of Upholstery Cover Material	(1) % of Furniture in Use, 1999-2002	(2) Ignition Propensity	(3) Weighted Ignition Propensity (1) × (2)	(4) % of Overall Risk <sup>1</sup>	(5) Annual Societal Costs per Unit	(6) Lifetime Societal Costs per Unit <sup>2</sup>
Severely Cigarette Ignition-Prone Cellulosics	12.7%	.93	.118	14.9%	\$1.06	\$12.86
Moderately-Cigarette Ignition-Prone Cellulosics	6.1%	.93	.057	7.2%	\$1.06	\$12.86
Less Cigarette Ignition-Prone Cellulosics	14.2%	.93	.132	16.7%	\$1.06	\$12.86
Thermoplastics	51.2%	.94	.484	61.2%	\$1.07	\$13.05
Leather, wool, vinyl-coated	15.8%	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>

<sup>1</sup> The Percent of Overall Risk for each type of upholstery cover material (column 4) is calculated by dividing weighted ignition propensity (column 3) by the summation of the weighted ignition propensities (0.791).

<sup>2</sup> Based on a 3% discount rate.

<sup>3</sup> Based on limited laboratory testing data, leather, wool, and vinyl-coated fabrics are assumed to be highly resistant to ignition from small open flames. Therefore, ignition propensity of these materials is small, but unknown, as are the annual and lifetime societal costs per unit covered with these materials.

probably would be lower. However, we note that a major intent of the staff's draft standard is limiting the burning rate of many filling materials so that fire growth would be slow enough to delay the onset of untenable fire conditions, including the generation of toxic combustion gases. To this end, the staff's draft standard incorporates requirements limiting the mass loss of interior filling materials over time. The ignition performance of these filling materials, which were not addressed by the small open flame standard drafted by the CPSC staff in 2001, should allow additional escape time for occupants of the residence, thereby reducing deaths and injuries. Therefore, improved ignition performance of filling materials under the staff's draft proposed standard should largely offset any reductions in effectiveness of FR fabric treatments vis-à-vis FR treatments intended to pass the 20-second small open flame fabric test of the 2001 CPSC staff draft standard. Consequently, the hazard reduction for furniture with FR-treated fabrics and complying interior filling materials may be about 80 percent. We also assume that 40 percent of furniture currently manufactured with severely cigarette ignition-prone cellulosic fabrics (accounting for 4.1 percent of all furniture items) would be used with barrier materials. Barriers would reduce the societal costs of small open flame ignitions by about 90 percent, based on previous estimates of the benefits of barriers used under the draft standard for small open flame ignition of furniture.<sup>58</sup> The average small open flame hazard reduction for severely cigarette ignition-prone cellulosic fabrics would, therefore, be about 84 percent (80% reduction x 60%) + (90% reduction x 40%).

Additionally, finished items made with untreated fabrics and complying filling materials could realize a reduction in societal costs associated with small open flame ignitions of about 50 percent.<sup>59</sup> This reduction would be attributable to improved ignition performance of filling materials, which, as noted above, is expected to slow the rate of fire growth and reduce the open flame ignition hazard.

The estimated benefits per unit were calculated in Table 4 as the product of lifetime per unit societal costs (column 3) and the expected hazard reduction (column 5), for each class of covering material. The resulting per unit benefits range from \$6.43 for furniture covered with less-to-moderately cigarette ignition-prone cellulosic fabrics, to \$10.81 for items currently covered by severely cigarette ignition-prone cellulosic fabrics. These estimated benefits per unit are shown in column 6 of Table 4. The benefits, if any, involving inherently ignition-resistant materials such as leather, wool, and vinyl-coated fabrics are small but unknown.

The aggregate estimated benefits are calculated in column 7 as the product of the estimated per unit benefits (column 6) and the annual number of units produced (column 2). Based on these calculations, estimated benefits of the standard, in the form

---

<sup>58</sup> *IBID.*

<sup>59</sup> Preliminary estimates of effectiveness are based on discussions with Directorate for Engineering Sciences staff, and may be refined following the analysis of composite flammability testing data gained from a testing program that is being planned.

**Table 4.**

**Small Open Flame Ignition Societal Costs and Estimated Benefits from Furniture Produced in a Year (in 2004 dollars)**

Material	(1) % of Annual Production	(2) Annual Units Produced	(3) Lifetime Societal Costs per Unit <sup>1</sup>  (Table 3)	(4) Total Estimated Societal Costs <sup>2</sup> (million \$)  (2) x (3)	(5) Estimated Hazard Reduction	(6) Estimated Benefits per Unit  (3) x (5)	(7) Total Estimated Benefits (million \$)  (2) x (6)
Severely Cigarette Ignition-Prone Cellulosics	10.32%	3,250,306	\$12.86	\$41.8	84%	\$10.81	\$35.1
Moderately Cigarette Ignition-Prone Cellulosics	4.94%	1,557,614	\$12.86	\$20.0	50%	\$6.43	\$10.0
Less Cigarette Ignition-Prone Cellulosics	11.54%	3,634,433	\$12.86	\$46.8	50%	\$6.43	\$23.4
Thermoplastics	42.96%	13,532,327	\$13.05	\$176.5	50%	\$6.52	\$88.3
Leather, wool, vinyl-coated	30.24%	9,525,321	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>	See note <sup>3</sup>
All Covering Materials	100.0%	31,500,000	\$9.05	\$285.1	--	\$4.98	\$156.8

<sup>1</sup> Based on a 3% discount rate.

<sup>2</sup> Based on estimated annual production of 31.5 million pieces of upholstered furniture for household consumption.

<sup>3</sup> Based on limited testing data, leather, wool, and vinyl-coated fabrics are assumed to be highly resistant to ignition from small open flames. Therefore, the societal costs (and, hence, the potential benefits) associated with these covering materials are small but unknown.

of expected lifetime reduction in societal costs of fires started by small open flames associated with production of furniture in one year, will total \$156.8 million.

## 6. EXPECTED COSTS OF THE DRAFT STANDARD

This section of the analysis presents information about the expected resource costs associated with the staff's draft standard. These costs include manufacturing costs incurred for materials, labor, testing, and recordkeeping, and distribution costs to wholesalers, distributors, and retailers. The estimates are expressed in 2004 dollars (as were estimated benefits). Cost estimates are limited to upholstered household furniture that may commonly be found in living rooms and family rooms. A relatively small number of other types of chairs that fall within the scope of the standard, such as a small percentage of dining chairs and desk chairs purchased by consumers, are excluded from this analysis.<sup>60</sup> Cost estimates are summarized in Table 5.

### 6.1. Costs Related to Upholstery Fabrics and Barrier Materials

#### 6.1.1. Upholstery Fabric FR Treatments

Fabrics failing the fabric test of the draft standard could be treated with FR chemicals or be reformulated with fibers that enable passing results. Manufacturers would also be able to continue using fabrics without modifications if they use an acceptable barrier material (*i.e.*, one that passes the draft Barrier Test) between the fabric and filling materials. For purposes of this analysis, the highly cigarette ignition-prone fabrics, estimated to account for 10.3 percent of total upholstery cover materials, are assumed to require the use of FR treatments or barriers if their use is to continue under the standard.

Based on fabrics that have been tested by the CPSC laboratory, many of the fabrics that would fail the fabric test of the staff's draft standard are heavier weight (over eight ounces per square yard) fabrics that are made entirely of cellulosic fibers, such as cotton or rayon. Many of these fabrics could be treated with FR chemicals to enable them to pass the fabric test. Typically, fully upholstered chairs require about 7 linear yards of fabric, and sofas require 11 to 15 yards, depending on factors such as the need to match patterns (which results in more fabric waste in pattern cutting). The average increase in fabric costs could range from \$.62 to \$1.05 per linear yard for manufacturers, based on previous estimates for FR backcoating to achieve resistance to ignition from small open flames.<sup>61</sup> Also, although the staff's draft standard does not

---

<sup>60</sup> Those other items probably would incur relatively minor increases in costs because of the types of materials used, and smaller material requirements per unit of furniture.

<sup>61</sup> Smith, Charles. Directorate for Economic Analysis, CPSC, *Economic Analysis of Regulatory Options to Address Small Open Flame Ignitions of Upholstered Furniture*, October 2001. Note: Bureau of Labor Statistics reports virtually no change in Producer Price Index for job or commission finishing of cotton broadwoven fabrics from 2001-2004. Therefore, previous estimates are used in this analysis.

Table 5.

## Estimated Increase in Manufacturing Costs (2004 Dollars)

Upholstery Covering Materials	Manufacturing Cost Increases per Unit, by Material Affected				(5) Compliance Verification Costs per Unit	(6) Distribution Costs per Unit	(7) Range of Total Costs Per Unit (Average)	(8) Annual Units Produced (% of Total)	(9) Aggregate Costs (million \$) (midpoint)
	(1) FR Fabric	(2) Barriers	(3) Urethane	(4) Fibrous Filling					
Severely Cigarette Ignition Prone Fabrics	\$6.61 to \$11.28 (60% of type)	\$15.90 to \$22.05 (40% of type)	\$2.05 (See Note)	\$1.46 (See Note)	\$0.20	\$1.40 - \$1.93	\$15.44 - \$21.23 (18.33)	3,250,306 (10.32%)	\$50.2 - \$69.0 (\$59.6)
Moderately Cigarette Ignition Prone Cellulosic Fabrics	n/a	n/a	\$3.41	\$2.44	\$0.20	\$0.60	\$6.65	1,557,614 (4.94%)	\$10.4
Lower Cigarette Ignition-Prone Cellulosic Fabrics	n/a	n/a	\$3.41	\$2.44	\$0.20	\$0.60	\$6.65	3,634,433 (11.54%)	\$24.2
Thermoplastic Fabrics	n/a	n/a	\$3.41	\$2.44	\$0.20	\$0.60	\$6.65	13,532,327 (42.96%)	\$90.0
Ignition Resistant Materials	n/a	n/a			See Note			9,525,321 (30.24%)	See Note
								31,500,000	\$174.8 - \$193.6 (184.2)

Note: Estimates of per unit urethane foam and polyester filling costs are based on the assumption that changes would not be necessary if barriers are used. Further, we assume that "Ignition Resistant Materials" will be qualified as barriers by the optional cover material barrier tests, thereby eliminating the requirements to use complying cushioning materials.

specify frequency of testing to assure compliance of treated fabrics with the fabric test, we assume that testing will be done to provide guaranties to furniture manufacturers. Based on our earlier evaluation of testing costs, this testing could increase fabric costs an additional \$.03 to \$.06 per linear yard of fabric, on average. Therefore, total average manufacturing cost increases for furniture made with FR-treated upholstery fabrics under the staff's draft standard could range from \$4.55 to \$7.77 for chairs and \$8.45 to \$14.43 for sofas and loveseats.<sup>62</sup> Considering estimates of unit shipments of chairs and sofas (based on an analysis of Department of Commerce *Economic Census* data), the average manufacturing cost increase per item of furniture resulting from FR treatments of fabric is estimated to range from \$6.61 to \$11.28.<sup>63</sup> (See column 1 of Table 5.)

### 6.1.2. Barrier Materials

Some furniture manufacturers may choose to offer fabrics that do not pass the fabric classification test by using an acceptable barrier material under the cover fabric. Based on barriers used in the UK to comply with the barrier test of that country's furniture flammability standard, the cost to manufacturers could range from \$2.00 to \$2.47 per linear yard (reportedly 54 to 59 inches in width) for standard FR barriers, and about \$2.67 to \$2.94 per linear yard for down-proof barriers (*i.e.* having yarns and weaves suitable for encasing down).<sup>64</sup> As with FR-treated cover fabrics, testing would be done to assure compliance with the barrier test of the draft standard. However, given expected large production runs of barriers and the greater degree of uniformity of barrier materials compared to cover fabrics, additional testing costs to furniture manufacturers could be about \$.01 per yard of barrier fabric.

The decision to use barriers as a means to comply with the standard is more likely to be taken by firms that serve the upper-end furniture market. These furniture items are more likely to be manufactured with interior fabrics between the cushioning materials and the upholstery covers. In a 1995 survey of furniture manufacturers, the CPSC found that about one-third of the seat, arm and back cushions were made with interior fabrics. Interior fabrics were used in an average of about 50 percent of cushions made by smaller firms, which are more likely to serve the upper-end market. To the extent that manufacturers already enclose filling materials in interliner fabrics, the FR barriers could be replacing untreated materials.

Cushions are usually purchased from fabricators that make them to the specifications of the furniture manufacturers. For seat cushions, the barrier alternative would result in a change in the interior fabric used by the cushion fabricators. For such items, barrier costs would be offset by the costs of the untreated materials, about \$.30 per yard for standard interliner fabrics and \$.80 per yard for down-proof interliner

---

<sup>62</sup> Assuming average fabric yardage for sofas and loveseats is 13 linear yards.

<sup>63</sup> We estimate that in 1997, upholstered living room and family rooms furniture purchased for consumer use was comprised of about 15.6 million sofas, sofabeds, and loveseats (52.7%), and 14.0 million chairs (47.3%). Therefore:  $(\$4.55 \times 47.3\%) + (\$8.45 \times 52.7\%) = \$6.61$ ; and  $(\$7.77 \times 47.3\%) + (\$14.43 \times 52.7\%) = \$11.28$ .

<sup>64</sup> Charles Smith, *op. cit.*

fabrics. Net increases in material costs, including costs for testing, would be about \$1.71 to \$2.18 per yard for standard fabrics and \$1.88 to \$2.15 per yard for down-proof fabrics. Cushions typically have sides that are about 24 inches long, and they are about 5 inches thick. Therefore, about one linear yard of 54-inch wide interior fabric would be used per seat cushion, and the cost increases per linear yard of material would also hold true for cost increases per cushion.

Barrier materials required for other parts of the seating areas of furniture items might require about two yards of material per chair and four yards per sofa. These areas may be less likely to have interliner fabrics currently than is the case with seat cushions. Therefore, increased material costs probably would be \$2.01 to \$2.48 per linear yard for standard FR barriers. These materials would increase material costs by about \$4.02 to \$4.96 for chairs and \$8.04 to \$9.92 for sofas. Adding the approximately \$1.71 to \$2.18 per cushion material cost increases from substituting the use of FR barriers for standard interliner materials, total increased material costs might be about \$5.73 to \$7.14 for chairs and \$13.17 to \$16.46 for sofas.

In addition to increased material costs, manufacturers would also be faced with additional costs related to labor needed to include FR barriers on parts of the upholstered items that are not currently made with interliner fabrics. The additional labor required might average about 15 to 20 minutes per item. Hourly labor costs, including benefits, reportedly can be as much as \$25 to \$30. Therefore, labor costs for the additional upholstery work could be about \$6.25 to \$10.00. Total increases in manufacturing costs (material and labor) are estimated to range from \$11.98 to \$17.14 for chairs and \$19.42 to \$26.46 for sofas and loveseats. The average increase in manufacturing costs per item of upholstered furniture that would be made with FR barriers is estimated to range from \$15.90 to \$22.05.<sup>65</sup> (See column 2 of Table 5.)

### 6.1.3. Aggregate Costs of FR Fabric Treatments and Barriers

As noted above, highly cigarette ignition-prone fabrics, estimated to comprise 10.3 percent of total upholstery cover materials, are assumed to require the use of FR treatments or barriers if their use is to continue under the draft standard. The use of barriers is more economically feasible with more expensive fabrics, such as those produced by members of the Decorative Fabrics Association (DFA). The DFA estimates that fabrics marketed by its members comprise perhaps 1.5 percent of total upholstery fabric yardage used to make furniture.<sup>66</sup> If 40 percent of highly cigarette ignition-prone fabrics (4.1% of all upholstery cover materials, *i.e.*, more than just the 1.5 percent of fabric yardage reportedly marketed by DFA members) are assumed to be used with acceptable barrier materials under a standard, about 1.2 million furniture pieces annually might be made with barriers under a standard. The aggregate manufacturing

<sup>65</sup> We estimate that in 1997, upholstered living room and family rooms furniture purchased for consumer use was comprised of about 15.6 million sofas, sofabeds, and loveseats (52.7%), and 14.0 million chairs (47.3%). Therefore:  $(\$11.98 \times 47.3\%) + (\$19.42 \times 52.7\%) = \$15.90$ ; and  $(\$17.14 \times 47.3\%) + (\$26.46 \times 52.7\%) = \$22.05$ .

<sup>66</sup> Information provided to the staff at a June 29, 2000, public meeting.

cost increase related to use of complying barrier fabrics under these assumptions would range from about \$20.7 million to \$28.7 million.<sup>67</sup> If 60 percent of highly cigarette ignition-prone fabric yardage (covering 6.2% of all furniture items) is assumed to be treated with FR chemicals, the estimated aggregate increase in manufacturing costs from FR treatment of fabrics would range from \$12.9 million to \$22.0 million annually.<sup>68</sup> The combined aggregate costs of fabric treatments and barriers would total \$33.4 million to \$50.7 million annually.

It should be noted that this analysis assumes that all furniture made with fabrics that fail the fabric test of the draft standard will continue to use those fabrics through the use of FR treatments or barrier materials. An alternative available to manufacturers will be reformulation of fabrics, such as through use of thermoplastic fibers or changes to other fabric characteristics. Also, some fabrics that do not pass the draft test could be discontinued. Change in manufacturing costs if these alternatives are chosen should be negligible. However, our cost estimates are based on compliance through either FR treatments of fabrics or the use of barrier materials. Therefore, aggregate estimated costs of FR fabric treatments and use of complying barrier materials may be overstated.

## 6.2. Costs Related to Urethane Foam Cushioning

The staff's draft standard includes smoldering and small open flame tests for resilient foam filling materials used in the manufacture of furniture. All future items will need to comply with these tests unless they use acceptable barrier materials. Based on current industry practice, the material that will be affected by this test is flexible polyurethane foam cushioning. Based on surveys of furniture manufacturers, this material is used in nearly all seat cushions, and is also a common cushioning material for furniture arms and backs. As noted in Section 3, the American Furniture Manufacturers Association (AFMA) reported that an estimated 350 million pounds of polyurethane foam were used in furniture production in 2002.<sup>69</sup> Compliance with the staff's draft standard will require reformulation of much of the polyurethane foam used in furniture production. However, furniture items made with acceptable barrier materials, or cover materials that qualify as barriers (*e.g.*, most leather, and wool and vinyl fabrics) could be made with standard urethane foam.

Under the staff's draft standard, the principal means of compliance for polyurethane foam will be the use of combustion modifying additives such as halogenated compounds in conjunction with organic phosphorus compounds. Some formulators might also use other combustion modifiers in their formulations, such as melamine. The polyurethane foam industry has experience with the use of combustion

---

<sup>67</sup> (31.5 million units x 4.1% x \$15.90) = \$20.7 million; (31.5 million units x 4.1% x \$22.05) = \$28.7 million.

<sup>68</sup> (31.5 million units x 6.2% x \$6.61) = \$12.9 million; (31.5 million units x 6.2% x \$11.28) = \$22.0 million.

<sup>69</sup> Bill Perdue, Director of Environmental and Technical Affairs, AFMA. Presentation at the Brominated Flame Retardants and Foam Furniture Conference and Roundtable. April 29 & 30, 2003. The association has since changed its name to the American Home Furnishings Alliance (AHFA).

modifiers because of flammability standards that have been imposed by the state of California which include ignition testing requirements applicable to polyurethane foam.

As shown below, the impact of the draft standard on urethane foam manufacturing will vary depending on densities of foam that are used. The addition of FR chemicals to lower density foams (*e.g.*, 1.0 pounds per cubic foot, or “pcf”) necessary to pass the CPSC staff’s draft standard may involve greater incremental costs per board foot than higher density foams. The incremental costs of FR chemicals reportedly continue to decline as foam density increases. Also, since the lower density foams might not have acceptable physical properties with added FR chemical loadings needed to pass the CPSC staff’s draft tests, more costly higher density foams might be necessary for certain applications. This would also contribute to greater incremental costs of compliance for lower density foams.

### 6.2.1. Seat Cushions

The staff’s draft standard incorporates testing requirements for flexible polyurethane foam that are similar to those of the proposed draft (2002) revision to California’s Technical Bulletin (TB) 117, the standard for upholstered furniture sold in that state.<sup>70</sup> Some flexible urethane foam manufacturers have reported that higher density foams (1.4 pcf and greater) that meet the current requirements of TB 117 will also meet the revised draft California requirements without modification. Results of limited testing by the CPSC’s Directorate for Laboratory Sciences indicate that urethane foams with densities of 1.4 pcf and greater that comply with the revised draft TB 117 can also pass the applicable tests drafted by the CPSC staff.

Higher density foam is commonly used in seat cushions. Although some low-cost furniture reportedly uses lower-density foam for this purpose, foams having densities below 1.2 pcf generally do not provide a support factor considered to be better-suited for load-bearing applications such as furniture seat cushions.<sup>71</sup> According to information provided by knowledgeable persons in the furniture and foam industries, about 25 percent of the polyurethane foam used in the production of furniture might now comply with the current version of TB 117. Thus, somewhat more than 75 percent of the flexible foam now used in seat cushions could require modifications to comply with the standard drafted by the CPSC staff.

The Polyurethane Foam Association (PFA) provided proprietary pricing information for urethane foams of various densities and flammability performance to the staff of the CPSC on August 31, 2005.<sup>72</sup> Pricing data was provided for bulk foam

---

<sup>70</sup> Although both draft tests for flexible foam subject foams in a test structure to an open flame, the test drafted by the CPSC staff specifies that the foam is to be covered by a standard fabric. Also, the CPSC staff and California draft open flame tests specify different mass-loss by time criteria in determining compliance.

<sup>71</sup> *In Touch: Information on Polyurethane Foam*, Polyurethane Foam Association. Volume I, Number 2, May 1991.

<sup>72</sup> James T. McIntyre, counsel for the PFA, letter to Dale Ray, Upholstered Furniture Project Manager, CPSC, August 31, 2005. (Attachment with proprietary business information on foam costs.)

purchases, and did not account for additional cushion fabrication costs typically incurred by furniture manufacturers. Pricing data are assumed to incorporate associated costs related to testing to verify compliance with the California standard. The Directorate for Economic Analysis estimated increased urethane foam cushion costs as charged by cushion fabricators, based on correspondence with a major foam manufacturer.<sup>73</sup>

The increased costs of producing foam that complies with flammability standards are inversely related to the density of the foam to be treated. Based on the pricing information provided by the PFA, complying seat cushions made with lower density foams (*e.g.*, 1.0 pcf) might incur cost increases averaging \$1.78 per cushion.<sup>74</sup> This estimated increase assumes that lower density foam, in addition to being FR-treated, would be increased in density to 1.4 pcf.<sup>75</sup> Complying cushions made with 1.4 pcf density foam may cost furniture manufacturers about \$.41 more per cushion. Seat cushions made with 1.8 pcf and denser foams would cost an estimated \$.21 more per seat cushion. Implicit in these cost estimates is the inclusion of testing costs in the price difference of complying foam.

An estimated 44 million seat cushions produced annually would be subject to the CPSC staff's draft standard's testing provisions for resilient foam.<sup>76</sup> If we assume that about 5 percent of these seat cushions, or 2.2 million annually, are made with low density (about 1.0 pcf) foam, increased annual foam costs for these cushions would be \$3.9 million (2.2 million cushions x \$1.78). About 10.5 million seat cushions (out of 44 million subject to testing requirements) would not require modifications under the standard, since they already comply with TB 117 (and are also assumed to comply with the CPSC staff's draft standard) and are made with foams of 1.4 pcf density and higher.<sup>77</sup> The average cost impact on the remaining estimated 31.3 million seat cushions will vary according to the density of foam used. As discussed above, for the remaining seat cushions made with foams that are 1.4 pcf are estimated to incur costs of about \$.41 each; cushions made with foams that are 1.8 pcf and greater may incur increased costs of about \$.21 each. If about 65 percent of all seat cushions that would be subject to the draft testing provisions are made with 1.8 pcf and greater density foam

---

<sup>73</sup> According to Bobby Bush, Vice President, Hickory Springs (in an e-mail correspondence with Charles Smith, Directorate for Economic Analysis, CPSC, September 8, 2005), a reasonable approximation of the value of the urethane component of seat cushions purchased from cushion fabricators is 150% of the board foot price of the foam as produced in "bun" form.

<sup>74</sup> Based on an average of 20 board feet per cushion that is 24 inches square and 5 inches deep. Estimates are based on estimated fabricated cushion costs, and on the assumption that 25% of lower density foam complies with TB117.

<sup>75</sup> However, it is possible that lower density foams could be produced in compliance with the draft standard, based on information provided by foam manufacturers. The development of lower density foams that comply with the draft standard would moderate the costs faced by furniture manufacturers.

<sup>76</sup> The total estimated number of seat cushions for annual furniture sales of 31.5 million units is 67 million. In addition to the estimated 44 million seat cushions that would be subject to the draft standard's testing provisions, urethane foam in an estimated 23 million other seat cushions would be used with acceptable barrier materials, and, therefore, would not be required to pass the tests for resilient filling materials.

<sup>77</sup> 44 million cushions x 25% (TB117 foam market share) x 95% (which are assumed to be foam of 1.4 pcf and greater) = 10.4 million cushions.

and 30 percent are 1.4 pcf, aggregate annual costs to bring the estimated 31.3 million seat cushions into compliance would be about \$8.6 million.<sup>78</sup> Therefore, total annual increased seat cushion costs would be almost \$12.5 million for all densities of urethane foam. For the estimated 20.7 million units affected annually, average costs per unit would be about \$.60 per item of furniture.

### 6.2.2. Other Urethane Foam Cushioning

About 152 million pounds of polyurethane foam are estimated to be used annually for furniture backs, arms and other locations.<sup>79</sup> This material is used in 25 percent to 30 percent of the arms, and in about 80 percent of the back cushions according to the most recent survey of manufacturers.<sup>80</sup> Since an estimated 34 percent of furniture units would be made with complying barrier materials, about 100 million pounds of this urethane would be affected by the draft tests for resilient filling materials.

Based on available information on densities of foam used by the furniture industry and our calculations of foam use for seat cushions, the average density of foams used in non-seat cushion applications is a little over 1.2 pcf. This yields an estimate of 972 million board feet annually that would be subject to the draft tests.<sup>81</sup> The estimated proportion of urethane use in these other applications that is 1.0 pcf foam is 62 percent.<sup>82</sup> Foams of about 1.4 pcf density account for almost 21 percent of board feet used in these applications, and 1.8 pcf and denser foams account for 17 percent.<sup>83</sup> Information provided by the industry indicates that 1.0 pcf density foam could incur cost increases of about \$.09 per board foot under the CPSC staff's draft standard, assuming FR-treated foam with a density of 1.4 pcf would be required.<sup>84</sup> Foams with density of 1.4 pcf used in these other applications could incur cost increases on the order of \$.02 per board foot, unless the foams previously complied with TB 117. Based on current compliance with TB 117 by about 25 percent of the urethane foam used in furniture production, the average increase for 1.4 pcf density foam could be about \$.015 per board foot (\$.02 x .75). Foams with densities of 1.8 pcf and greater would incur estimated cost increases of about \$.01 per board foot; average costs would be about 25 percent lower because of compliance with TB 117. The weighted estimated aggregate

<sup>78</sup> These assumptions lead to an estimated 9.9 million seat cushions with 1.4 pcf foam and 21.4 million cushions with 1.8 pcf and denser foam that would require FR modifications averaging \$.41 and \$.21 per cushion, respectively.

<sup>79</sup> This is based on an estimated total of 67 million urethane seat cushions on 31.5 million pieces of furniture produced annually (including cushions made with barrier materials). If 65% of cushions are made with 1.8 pcf and denser foam having an average density of 2.0; 35% of cushions are made with 1.4 pcf foam; and 5% of cushions are made with 1.0 pcf foam, total estimated foam consumption for seat cushions is 198 million pounds annually, out of total annual urethane use of 350 million pounds. This leaves an estimated residual of 152 million pounds of urethane foam consumed annually for furniture applications other than seat cushions.

<sup>80</sup> Smith, Charles. Directorate for Economic Analysis, CPSC, "Results of Surveys of Manufacturers of Upholstered Furniture," September 1996.

<sup>81</sup> 100 million lbs./1.235 pcf = 81 million cubic feet. 81 million cubic ft. x 12 board ft./cubic ft. = 972 million board ft.

<sup>82</sup> Calculated as a residual for non-seat cushion uses if 35% of total urethane foam use is 1.0 pcf foam.

<sup>83</sup> Calculated as residuals if 25% of all foam use is 1.4 pcf and 35% is 1.8 pcf and greater.

<sup>84</sup> Cost estimates are based on pricing information submitted to the CPSC staff by PFA on August 31, 2005, increased by a factor of 150% to account for costs of fabrication.

cost increase of urethane foam used in applications other than seat cushions is about \$58 million annually.<sup>85</sup> For the estimated 20.7 million furniture units made without acceptable barrier materials or barrier fabrics, this would average about \$2.81 per item of furniture.

### 6.2.3. Summary of Costs Associated with Polyurethane Foam Cushioning

The overall estimated increase in polyurethane foam costs, including seat cushions and cushioning in other parts of furniture, totals about \$3.41 per unit of furniture affected by the draft standard's testing provisions for resilient filling materials. (See column 3 of Table 5.) Since cushioning materials used with complying barrier materials (including cover materials that qualify as barriers under the optional cover material barrier test of the draft standard) do not have to comply with material tests, aggregate costs may total about \$71 million.<sup>86</sup>

### 6.3. Costs Related to Fibrous Filling Materials

Like the UK standard for upholstered furniture flammability, BS 5852, the staff's draft standard incorporates testing requirements for fibrous filling materials. However, the draft test developed by the CPSC staff incorporates a standard test fabric that probably results in a more stringent test of the filling material. Officials with the furniture industry and materials suppliers and the director of the major testing firm in the UK maintain that, in order to pass BS 5852, modifications are necessary for polyester fiberfill that has been coated with a slickening agent such as silicone to facilitate blowing the material into pre-sewn loose back cushions. However, non-slickened polyester and FR cotton batting reportedly can pass the non-foam resilient filling material test of BS 5852.

Alternative fiberfill formulations that comply with the BS 5852 test are commercially available which would facilitate blowing the loose material into back cushions. At least one material supplier to the UK furniture trade, Wellman Fiber, has developed a lubricant that enables loose fiberfill to be blown into cushions, but still yields a product that can pass the performance test of the UK standard. The complying fiberfill reportedly costs about \$.10 more per pound than siliconized fiberfill.<sup>87</sup> However, information indicating that this material would pass the CPSC staff's draft fibrous filling test is currently not available. Materials that are blends of siliconized polyester and FR fibers reportedly are available at costs that are \$1.00 or more per pound greater than the cost of slickened polyester.<sup>88</sup> Since these products are not

---

<sup>85</sup> (972 million board feet X 62% X \$.089 cost difference) + (972 million board feet X 21% X \$.015 cost difference) + (972 million board feet X 17% X \$.008 cost difference) = \$58 million

<sup>86</sup> Based on about 20.7 million units produced annually without either qualifying barriers or qualifying barrier fabrics.

<sup>87</sup> Joe McFayden, Wellman Fiber, in a telephone conversation with Charles Smith, Directorate for Economic Analysis, CPSC. August 30, 2004.

<sup>88</sup> Bobby Bush, Vice President, Hickory Springs, in a telephone conversation with Charles Smith, Directorate for Economic Analysis, CPSC. May 13, 2004.

widely used by the furniture industry, it may be reasonable to assume that initial per unit costs would be lower in the future. Given the range of costs of products that might comply with the draft CPSC staff's test, for purposes of this analysis the resulting increase in material costs for fiberfill is assumed to be about \$.75 per pound. If a back cushion contains about 3 pounds of fiberfill, the increased material cost to the furniture manufacturer could total \$2.25 per chair and \$6.75 or more per sofa (assuming three seat cushions per sofa). The average cost per upholstered item could be about \$4.88 based on the proportions of chairs and sofas in annual production. If about 50 percent of furniture backs are made with blown slickened polyester fiber, the average per unit cost increase associated with polyester fiberfill would be about \$2.44 per item of furniture.<sup>89</sup> (See column 4 of Table 5.) Aggregate increases in manufacturing costs could be about \$50 million annually.<sup>90</sup>

The staff's draft standard contains provisions that permit manufacturers to use complying barrier interliner materials to encase noncomplying filling materials such as siliconized polyester fiber. Based on information on barrier costs presented in section 6.1.2., the per-unit manufacturing costs of this alternative means of compliance could be similar to those estimated for FR modifications to loose polyester fiber.

The Directorate for Economic Analysis assumes that cotton batting currently used in the manufacture of furniture, which is treated with boric acid for flame retardance, will comply with the staff's draft proposed standard without significant increases in costs for the material. If the material, as a result of the standard, becomes lower in cost in relation to other materials for some applications, its use by the furniture industry could increase.

#### **6.4. Costs Related to Compliance Verification**

Costs related to compliance verification will result from requirements placed on furniture manufacturers to maintain records and to apply a permanent label to the items.<sup>91</sup> Other resource costs of compliance verification include the costs of compliance and enforcement activities undertaken by CPSC staff. These costs, addressed below, may total about \$6 million annually. Average costs could be as much as \$.20 per item of furniture. (See column 5 of Table 5.) The components of these compliance verification costs are discussed below.

---

<sup>89</sup> The staff's draft standard allows furniture manufacturers the option of encasing non-complying polyester in fabric that complies with the loose filling material interliner fabric smoldering and open flame ignition tests. Based on estimated costs of the use of barrier materials in seat cushions, discussed in Section 6.1.2., the costs to manufacturers to use FR interliner fabrics might be about the same as the costs of complying polyester-based loose filling materials.

<sup>90</sup> Based on about 20.7 million units produced annually without either qualifying barriers or qualifying barrier fabrics.

<sup>91</sup> Costs related to production testing are incorporated in the estimated material costs of the draft standard.

#### 6.4.1. Costs to Industry Related to Recordkeeping

Subpart B, Section 1634.22, of the staff's draft standard specifies test and manufacturing records that must be prepared by furniture manufacturers, and maintained for a period of three years after items are produced. These records shall include sufficient information to identify products and related information that provides an objectively reasonable basis for certification of compliance with the rule (e.g., guaranties for each upholstered furniture material provided by suppliers, or records of reasonable and representative tests demonstrating compliance). For each certification family (all the items of upholstered furniture of a specific "Type" that rely on the same basis for certification, such as guaranties or reasonable and representative tests), manufacturers shall maintain records sufficient to identify all articles of upholstered furniture comprising the certification family; identify the supplier of each upholstered furniture material used in the upholstered furniture comprising the certification family; and identify each retailer and other non-consumer customer to whom sales of upholstered furniture from the certification family have been made.

Incremental costs related to recordkeeping would depend, in part, on the extent to which furniture manufacturers currently maintain records identifying upholstery fabrics and filling materials with finished items. Small firms with limited product lines may require additional labor of less than one man-month a year to maintain the records. Large firms with broad product lines may require the equivalent of an additional full-time employee. Depending on media used to store records, additional office space may also be required. While the recordkeeping costs are uncertain, if average annual costs would be about \$2,000 per firm, aggregate annual costs may be about \$3.4 million. Average increased costs to manufacturers would be about \$.11 per item.

#### 6.4.2. Labeling Costs

Section 1634.24 of Subpart B of the staff's draft standard specifies labeling requirements for furniture subject to the standard. The rule would require a permanent, conspicuous, and legible label on all items. The staff's draft standard provides that labels must contain the manufacturer or importer name and location; month and year of manufacture; model identification; and type identification indicating the means of compliance (i.e., "Type I," "Type II," "Type III," "Type IIIB," "Type IV"). This information must be separate from other label information. The label would help retailers and consumers identify products and materials, e.g., in the event of a recall or other corrective action. The costs of labeling could be a few cents per item, based on reported labeling costs under the UFAC Voluntary Action Program and estimates provided by a manufacturer of labels.

### 6.4.3. Costs to the CPSC Related to Compliance and Enforcement

Compliance and enforcement costs refer to the costs incurred by CPSC to ensure that manufacturers are complying with the staff's draft proposed standard. Based on past experience, the estimated CPSC staff time per establishment visit may amount to about 39 hours for inspectors and 20 hours for compliance officers. Given average staff resource costs of about \$43 per hour for inspectors and \$52 per hour for compliance officers, the staff resource costs per plant visit would average about \$2,717 (39 hours x \$43 + 20 hours x \$52).

While no formal compliance and enforcement plans have been developed, discussions with the CPSC Office of Compliance suggest that as many as 250 establishments might be inspected annually under an upholstered furniture standard. This would result in total annual staff resource costs of about \$679,250 ( $\$2,717 \times 250$  inspections). In addition to staff resource costs, staff will incur the costs of collecting and testing samples from establishments that do not have sufficient records to demonstrate compliance with the standard. These costs are not known. However, if overall sample collection and testing costs would approximately equal staff resource costs, total compliance and enforcement cost might amount to as much as \$1,358,500 annually. It seems unlikely that these costs could be sustained by the CPSC on an annual basis over the long term. Nevertheless, such compliance and enforcement costs would amount to an average of about \$.04 per furniture unit produced annually ( $\$1,358,500 / 31.5$  million units of furniture).

### 6.5. Distribution Costs

An additional cost of the staff's draft standard could be increases in costs to wholesalers, distributors, and retailers in the form of added storage, transportation, and inventory financing costs. Since furniture items that would be produced under the standard are not likely to be larger or heavier than pre-standard items, added storage and transportation costs are likely to be negligible. However, inventory financing costs will increase by the average cost of borrowing money, applied to the increase in the wholesale price of a furniture item over the average inventory holding time period. Since most furniture producers use just-in-time production and have small inventories of finished items, this additional cost will probably not exceed 10 percent of the increase in manufacturing costs. A 10 percent markup, therefore, is being used to measure these distribution costs. This yields a resource cost to the firms in the distribution chain averaging about \$1.40 to \$1.93 per furniture item made with FR-treated fabrics or barriers, and about \$.60 per unit for other furniture items. (See column 6 of Table 5.) Aggregate costs associated with estimated increased inventory financing costs range from \$15.9 million to \$17.6 million annually. As discussed in Section 7, the staff's draft proposed standard may lead to increases in retail prices of furniture greater than the 10 percent markup. The possible increase in retail outlays by consumers is addressed in greater detail in that section.

## 6.6. Summary of Expected Costs

Table 5 summarizes the results of the cost analyses. It illustrates the differing costs estimated to be incurred under the standard by furniture items covered with the different classifications of upholstery materials previously discussed in the societal costs and benefits section of this analysis. The estimated 10.3 percent of furniture items covered by severely cigarette-ignition-prone celluloseics would incur greater total and per unit costs under the draft standard. We assume these fabrics would fail the upholstery cover fabric smoldering ignition resistance test of the draft standard. Therefore, their continued use in furniture production would require FR treatments that allow them to pass the fabric test, or the use of barrier materials that pass the barrier test of the draft standard. The estimated total costs of compliance range from about \$13.93 to \$19.06 per unit of furniture made with complying filling materials and fabric treated with FR chemicals to pass the smolder ignition resistance test.<sup>92</sup> For items made with complying barrier materials (allowing the use of non-complying fabric and filling materials) estimated total costs of compliance range from about \$17.71 to \$24.48 per unit.<sup>93</sup> Assuming 60 percent of severely cigarette-ignition-prone celluloseics would be made with FR-treated fabrics and complying filling materials and 40 percent would be made with barriers, the weighted range of estimated costs is \$15.44 to \$21.23. Total estimated aggregate costs for furniture covered with these fabrics range from \$50.2 million to \$69.0 million, or about 32 percent of aggregate costs estimated for all furniture items. (See column 9 of Table 5) As noted above, since changes in fiber contents of fabrics or dropping fabrics from selections offered by manufacturers will be an option available to manufacturers, the aggregate manufacturing costs related to FR treatments and barriers could be lower.

Furniture items covered with other types of upholstery materials, ranging from moderately cigarette-ignition-prone celluloseics to ignition-resistant leather, wool, and vinyl-coated fabrics, should not require FR-treated fabrics or barriers. However, all would require filling materials that comply with other material tests of the draft standard, unless the cover material is also qualified as a barrier. We assume that cover materials such as leather, wool, and vinyl-coated fabrics would pass the optional cover material barrier test. Therefore, items covered with these materials would not incur significant costs for cushioning materials under the draft standard. We assume that all items that are made with complying cushioning materials would incur similar per unit cost increases, with total increases varying according to current estimated market shares and annual units produced (shown in column 8 of Table 5).

---

<sup>92</sup> Based on estimated fabric treatment costs of \$6.61 to \$11.28 per unit; urethane costs of \$3.41 per unit; costs of \$2.44 for fibrous filling; \$.20 for compliance verification costs; and \$1.27 to \$1.73 for distribution costs (10%).

<sup>93</sup> Based on estimated barrier cost of \$15.90 to \$22.05; \$.20 for compliance verification costs; and \$1.61 to \$2.23 for distribution costs (10%).

Based on the estimated increases in manufacturing costs associated with changes in fabrics and filling materials, aggregate increases in manufacturing costs, costs of recordkeeping, and distribution costs under the draft standard are estimated to range from \$174.8 million to \$193.6 million annually. The midpoints of the estimated ranges of costs total \$184.2 million.

## 7. COMPARISON OF COSTS AND BENEFITS

### 7.1. Benefits and Costs of the Draft Proposed Standard

The expected benefits of the staff's draft standard, which will vary depending on the cigarette ignition propensity of the upholstery cover material used, were discussed in Section 5 (and shown in Tables 2 and 4) and are summarized in Table 6 on the following page. Table 6 shows the estimated benefits (per unit of furniture) in columns 1, 2, and 3. For example, the benefits associated with bringing furniture pieces now covered with severely cigarette ignition-prone cellulosic fabrics into compliance are estimated to total \$166.29 per unit (comprised of \$155.48 from reduced losses from furniture fires started by cigarettes and \$10.81 from reduced losses from fires started by small open flames). The projected benefits resulting from modifications to furniture covered with other types of covering materials range from \$87.59 per unit for items covered by moderately cigarette ignition-prone cellulosic fabrics to \$10.31 for items covered with predominantly thermoplastic fabrics. The benefits for items covered with cigarette and open flame-ignition resistant materials such as leather have not been projected, but they are assumed to be small.

Table 6 also shows (in column 4) the midpoints of the ranges of estimated per unit costs of compliance with the draft standard, which were derived in Section 6 (and shown in column 7 of Table 5). For example, items covered by severely cigarette ignition prone cellulosic fabrics were estimated to incur costs ranging from \$15.44 to \$21.23, with a midpoint in the estimated range of \$18.33 per unit. Furniture items covered with most other materials were estimated to incur average total costs of \$6.65. Furniture items covered with ignition resistant materials, such as leather, probably will incur small average total costs; however, information that would enable us to estimate these minor costs is not available at this time.

Subtracting the midpoints of estimated ranges of costs from the projected benefits yields per unit estimated net benefits. As shown in column 5 of Table 6, net benefits per unit are estimated to range from \$3.66 for items covered with thermoplastic fabrics to \$147.95 for items covered with highly cigarette ignition-prone fabrics (in the absence of a standard).

Table 6 also shows aggregate and cumulative net benefits associated with the staff's draft proposed standard. The total net benefits shown in column 7 are the

Table 6.

## Estimated Costs and Benefits of the Draft Standard

(Per Unit and Aggregate for Production in One Year, in 2004 Dollars)

Type of Upholstery Cover	Projected Benefits Per Unit, by Source of Ignition			(4) Costs Per Unit	(5) Net Benefits per Unit	(6) Annual Units Produced ----- (% of Total)	(7) Total Net Benefits (million \$)	(8) Cumulative Net Benefits (million \$)
	(1) Cigarettes	(2) S.O.F.	(3) Total Benefits					
Highly Cigarette Ignition-Prone Fabrics	\$155.48	\$10.81	\$166.29	\$18.33	\$147.95	3,250,306 (10.32%)	\$480.9	\$480.9
Moderately Cigarette Ignition-Prone Cellulosic Fabrics	\$81.16	\$6.43	\$87.59	\$6.65	\$80.94	1,557,614 (4.94%)	\$126.1	\$607.0
Lower Cigarette Ignition-Prone Cellulosic Fabrics	\$26.47	\$6.43	\$32.90	\$6.65	\$26.25	3,634,433 (11.54%)	\$95.4	\$702.4
Thermoplastic Fabrics	\$3.78	\$6.52	\$10.31	\$6.65	\$3.66	13,532,327 (42.96%)	\$49.5	\$751.8
Ignition Resistant Materials	See note					9,525,321 (30.24%)	See note	

Note: Based on limited ignition testing data, societal costs, and, hence, any potential benefits associated with ignition resistant materials such as leather, wool, and vinyl-coated fabrics are assumed to be small, but are unknown. Assuming these materials pass the optional cover material barrier tests, compliance costs for such furniture items would also be minimal.

product of per unit net benefits and number of units produced annually by type of cover material. For example, the total net benefits from furniture covered with moderately cigarette ignition-prone cellulosic fabrics amounts to \$126.1 million, given by the product of 1.56 million units produced and per unit net benefits of \$80.94. The cumulative net benefits (shown in column 8 of Table 6) are calculated by the vertical summation of the "Total Net Benefits" column. Total net benefits of the staff's draft standard are estimated to be \$751.8 million. This analysis assumes that manufacturers would use FR treatments in a manner that poses no additional risk of injury or adverse health effects to consumers.

## 7.2. Sensitivity Analysis

The previous analysis compares benefits and costs of the staff's draft standard using a discount rate of 3 percent to express expected benefits accruing in the future in their present value, an estimated value of a statistical life of \$5 million, and an estimated average cost of injury of \$187,449. Net benefits were also estimated based on estimated increases in costs of producing and marketing furniture that complies with the draft standard. In addition to these factors, the estimation of benefits was based on assumptions regarding the effectiveness of the standard at reducing losses from cigarette and small open flame ignitions. This section examines the effect of changing any of these assumptions on the expected net benefits that would result from compliance with the draft standard. In all cases, the estimated net benefits of the draft proposed standard remain positive.

A discount rate of 3 percent was used to express expected benefits accruing in the future in their present value. Using this rate, total estimated benefits of the standard are \$936 million, the midpoint of the range of estimated total costs is \$184.2 million, and total net benefits are \$751.8 million. To show the sensitivity of the results to the 3 percent discount rate, societal costs were also discounted at a rate of 7 percent. A higher discount rate decreases the present value of the future expected benefits. In the case of a 7 percent discount rate, the present value of benefits over an expected 16-year product life of a piece of furniture is decreased by about 28 percent from that estimated with a 3 percent discount rate. Costs would not be affected since they are incurred in the year of production. Using a 7 percent discount rate, the present value of the total estimated benefits of the standard would be about \$670 million; consequently, with total costs of \$184.2 million, total net benefits would be about \$486 million.

Estimated benefits of the staff's draft standard were based on a value of a statistical life of \$5 million. If benefits are calculated based on a lower bound of \$3 million as the value for a statistical life,<sup>94</sup> total estimated benefits of the standard would be about \$613 million, and total net benefits would be \$429 million. Alternatively, if a

---

<sup>94</sup> Viscusi, W. Kip. *op. cit.*

value of \$7 million is assigned to a statistical life, total estimated benefits would increase to about \$1,259 million; total net benefits would increase to about \$1,074 million.

Estimated benefits of the staff's draft proposed standard are based on an average societal cost of \$187,449 per injury. Changing the estimate used for the cost of injury will have minimal impact on the results, because the share of benefits from reduced injuries is only 6.5 percent of total benefits. Hence, even if there were no reduction in injuries from the draft proposed standard, the total estimated benefits would be \$875 million and total net benefits would be \$691 million.

Section 6 addresses the expected costs of the standard. Estimates of costs are based on judgments regarding changes to materials that will be required to meet performance tests of the draft proposed standard, the costs of those changes per unit, and the number of affected furniture items produced annually. Based on the midpoints of ranges of estimated cost impacts of material changes, aggregate costs of the standard were estimated to be \$184.2 million for annual production of upholstered household furniture. With these costs, total estimated net benefits of the draft proposed standard are \$751.8 million. Even if we assume that the costs of the standard are twice those estimated in Section 6 (*i.e.*, \$368.4 million) the standard would still have estimated net benefits totaling \$568 million from annual production of upholstered furniture.

Estimated benefits of the staff's draft standard were based on assumptions regarding the effectiveness at reducing societal costs of cigarette and small open flame ignitions of furniture. However, if we assume that the standard will have one-half the effectiveness that our estimated benefits are based upon, aggregate benefits would still be about \$468 million, and net benefits would be about \$284 million.

### **7.3 Impact of the Draft Proposed Standard on Retail Prices**

The estimated costs of the staff's draft standard include the increased costs of materials, labor, and distribution directly attributable to the rule. It is likely that manufacturers will pass on at least some of the costs of complying with the standard to the consumer, in the form of higher retail prices. The actual increase in retail prices will depend on the price elasticity of demand for furniture products (*i.e.* the responsiveness of quantity demanded to the change in price). If demand is highly price elastic, then manufacturers will experience a relatively large decrease in sales of upholstered furniture products in response to a price increase, and their ability to pass on increased regulatory costs to the consumer is limited. If demand is price inelastic, consumers respond less intensely to price increases, enabling producers to successfully pass through cost increases.

Regarding the market for upholstered furniture, it is anticipated that demand is relatively price elastic in the short run, because consumers can always postpone the purchase of a durable good. Increases in retail prices are thus likely to be limited. In the long run, demand is less elastic and any attempt to pass through increased costs is

more likely to succeed. Consequently, increases in retail prices are more likely to be observed.

In the absence of information on the price elasticity of demand for upholstered furniture products, it is possible to make use of traditional industry markup rates to provide an upper bound estimate for retail price increases. Such estimates may be viewed as upper bound estimates because they do not reflect the price elasticity of demand. Moreover, traditional markups do not factor in the role of competition, which can also influence attempts to increase prices. Rather, the markup simply reflects the price that producers will want to charge based on historical accounting costs. As noted above, an increase in price will result in a reduction in sales and in the case of highly elastic demand, revenues will decline as well, which will tend to moderate attempts to increase retail prices.

According to industry sources, higher production costs for materials and labor could result in retail prices that are higher by a factor of 2.5, or 150 percent. Based on this markup, the average retail price impact of the draft proposed standard on furniture items made with FR treated fabrics could be \$37.49 (for about 6 percent of all items), and the average retail price impact for furniture produced with barrier materials could be \$47.94 (for about 4 percent of furniture items). The average retail price impact for furniture that will require complying cushioning materials, but not FR fabric treatments or barriers under fabrics (perhaps 60 percent of units), could be \$15.13 per unit. Any increases in retail prices of furniture covered with ignition-resistant materials that pass the optional cover material barrier test (perhaps 30 percent of units) should be minor -- associated with minor testing and compliance verification costs for this furniture. The average increase in retail prices for all upholstered furniture is estimated to be about \$13.29 per item, based on the traditional industry markup rates.

## **8. ALTERNATIVES TO THE DRAFT STANDARD**

This section evaluates a number of possible alternatives to the staff's current draft proposed standard, including an alternative that primarily addresses open flame ignited fires; adoption of an industry proposal as a mandatory rule; adding a small open flame ignition resistance test for cover fabrics; adopting only provisions of the draft standard relating to smoldering ignition resistance; adopting requirements without open flame provisions for loose fill; requiring product labeling that warns consumers about the flammability hazards; alternative effective dates; and the alternative of taking no regulatory action by the CPSC. The CPSC staff plans to evaluate other alternatives that may be identified during the rulemaking proceeding.

## 8.1. Adoption of the Draft Small Open Flame Ignition Standard

As an alternative to the staff's proposed draft standard, the Commission could adopt the standard drafted by CPSC staff in 2001 that focused on small open flame ignition of upholstered furniture. That draft standard was the subject of a staff briefing package submitted to the Commission in October 2001. Compliance with the draft small open flame standard would require the use of upholstery cover materials that do not sustain combustion following exposure to a small flame for 20 seconds, or, alternatively, the use of materials that would pass a barrier test. The staff estimated that most fabrics would fail the 20-second flame test unless they would be treated with FR chemicals. Although the FR treatments under that standard specifically addressed small open flame ignition hazards, CPSC testing data also showed substantial improvement in cigarette ignition resistance. In fact, most of the estimated benefits of the small open flame standard were projected to result from reductions in societal losses from cigarette ignitions.

Based on estimated costs of compliance and estimated reductions in both small open flame and cigarette ignition hazards, adoption of the 2001 draft small open flame standard would result in estimated aggregate benefits totaling \$1,031 million and aggregate costs of about \$282 million from annual production of about 31.5 million pieces of upholstered furniture.<sup>95</sup> Therefore, estimated aggregate net benefits of the small open flame standard would be \$749 million. This compares with estimated net benefits of \$751.8 million for the current proposed draft standard.<sup>96</sup>

While the estimated net benefits of the CPSC staff's current draft proposed standard are about the same as the alternative open flame standard, the costs associated with the current draft proposal are substantially less. In fact, the estimated costs of the draft proposal (\$184 million) are about 35 percent lower than the costs of the alternative draft small open flame standard (\$282 million). The difference is related, in large part, to the reduced level of treatment of upholstery fabric with FR chemicals. Unlike the current draft standard, which would result in the treatment of roughly 6 percent or less of upholstery fabric coverings, nearly 66 percent of the upholstery covers would likely receive FR treatments to pass the 20-second open flame test of the CPSC staff's 2001 draft standard.

---

<sup>95</sup> Smith, Charles, *op. cit.* Based on "Best Estimates" of reductions in ignition propensity and midpoints of estimated increases in manufacturing costs; as with the current analysis, distribution costs are estimated to be an additional 10 percent. The best estimate for cigarette ignition reduction involving cellulosic fabrics is 75%, based on 2003 estimates made by Mark Levenson, EPHA, CPSC.

<sup>96</sup> The higher net benefits of the staff's current draft proposal may also be underestimated. The difference does not take into account the likely heavier (and hence more costly) loadings of FR chemicals that would be needed to meet the 20-second open flame test of the alternative open flame standard. (For purposes of comparison, the FR treatment costs between these two alternatives were assumed to be the same.) Nor does it take into account the likelihood that, under the staff's current draft proposal, some manufacturers are likely to choose a lower cost option of simply substituting a complying fabric or modifying the fiber content of the fabric slightly to comply with the smoldering test, rather than treat fabrics with FR chemicals or barriers. This is less likely under the alternative open flame standard because almost all fabrics would have to be treated to meet the 20-second open flame test.

It should also be noted that retail price impacts of the staff's current draft proposed standard, reflecting the lower underlying costs, would also be substantially lower than under the alternative open flame standard. Increases in the retail price of furniture may have some negative impact on sales. Higher prices may lead some consumers to delay the purchase of new furniture or lead them to buy it less frequently, and could potentially result in secondary impacts on the sales of furniture components and industry employment; such effects are likely to be more pronounced in the short run. While the impact of these price increases cannot be predicted with any certainty, the higher costs of the alternative open flame standard would likely have more pronounced effects. Additionally, while the retail price impact of the current draft proposed standard will fall most heavily on more expensive furniture items (*i.e.*, those with the more expensive cellulosic fabrics), the alternative open flame standard would fall disproportionately on the more inexpensive furniture with thermoplastic fabrics, the fabrics less prone to cigarette ignition.

Finally, while the volume of FR chemicals used under the two alternative standards may be similar, the usage patterns would be different. The alternative open flame standard could have resulted in about 50 million pounds of FR chemicals being used annually to treat upholstery cover fabric. Under the current draft proposal, however, an estimated 1 to 8 million pounds of FR chemicals would be used to treat cover fabric; the remainder would be used to treat filling materials.<sup>97</sup> This change in resulting FR chemical use addresses some industry concerns that the use of FR treated-fabrics could reduce the aesthetic quality of upholstery fabrics. It will also reduce the potential for human exposure to FR-treated cover fabrics.

## **8.2. Adoption of Requirements Proposed by the Furniture Industry Association as a Mandatory Rule**

In a May 13, 2004, letter to the CPSC, the American Furniture Manufacturers Association (which has since changed its name to the American Home Furnishings Alliance) proposed a set of provisions as a basis for a mandatory flammability standard for furniture. This proposal ("the industry proposal") was supported by representatives of organizations representing manufacturers of furniture, bedding, fabrics, filling materials, and FR chemicals in a July 12, 2004, letter. The proposal recommended that upholstery cover fabrics tested on a 45 degree test fixture be required to resist ignition or self-extinguish after exposure to a small open flame for 5 seconds; or, if ignition occurs, the time until the flaming progresses to the ends of the fabric samples shall be longer than 30 seconds. Failing fabrics could only be used with appropriate cigarette and open flame resistant barrier materials (which would comply with a barrier test to be determined by the CPSC).

---

<sup>97</sup> Franklin, Robert. *Preliminary Environmental Assessment of a Draft Proposed Flammability Standard for Residential Upholstered Furniture*. November 2004.

The industry proposal also specified ignition testing criteria based on other flammability standards that would apply to filling materials. For example, the cigarette and open flame provisions of the February 2002 draft revision to the California standard for upholstered furniture flammability (TB 117) would apply to urethane foam and other seat cushion core materials; polyester fiberfill used in seat cushion wraps or toppers would comply with the open flame provisions of the UK furniture standard (BS5852); and cotton batting and polyester batting used in arms would comply with the cigarette ignition resistance provisions of ASTM E 1353.

Costs of a standard based on the industry proposal likely would be much lower than those estimated for the staff's current draft proposed standard. Based on a limited survey of fabric producers by the Directorate for Economic Analysis in 1998, a very high percentage of fabrics that could require FR treatments to pass the fabric test proposed by the industry already might be backcoated for purposes other than fire resistance, such as dimensional stability, crease resistance, and strength of the fabrics. Therefore, most fabrics that would be treated with FR chemicals probably would have the chemicals incorporated in the backcoating formulations that are now intended for other purposes. Relatively small amounts of FR chemicals might be required in backcoating formulations to bring failing fabrics into compliance with the fabric test requirement of the industry proposal.<sup>98</sup> If formulating backcoatings with FR chemicals to meet the industry proposal's fabric test results in backcoatings that are about the same weight as typical backcoatings applied for non-FR purposes, the impact on production may be minimal, and the incremental cost for backcoating could be small.

The Directorate for Laboratory Sciences tested 34 non-FR upholstery fabrics using the test method proposed by the industry.<sup>99</sup> Those tests showed that 100 percent cellulosic fabrics heavier than 7 ounces per square yard, and wool, leather and vinyl fabrics are likely to pass without modifications. Varying results were found for other fabrics, including those made from blends of cellulosic and thermoplastic fibers. Based on this limited testing, if we assume that no more than 40 percent of upholstery cover materials were to include FR chemicals in existing backcoating formulations, up to 130 million linear yards could be affected annually by a standard based on the industry proposal.<sup>100</sup> Based on earlier estimates of the costs of non-FR backcoating (\$.05 to \$.30 per linear yard), the FR backcoating formulations might add roughly \$.10 to \$.20 per linear yard, and annual costs for FR treatments may total \$13 million to \$26 million. Costs of including FR in backcoating formulations could average \$.41 to \$.83 per item of

---

<sup>98</sup> Based on comments by David Pettey (Quaker Fabric Corp.) that the total weight of FR-formulation backcoatings to meet the industry's proposed test is approximately the same as that of backcoatings normally used on fabrics for non-flammability purposes. October 2004 Public Meeting.

<sup>99</sup> Tao, Weiyang. Division of Electrical and Flammability Engineering, Directorate for Laboratory Sciences, CPSC. Memorandum to Dale Ray, CPSC Upholstered Furniture Project Manager, "Assessment of Fabric Open Flame Test Methodology," May 9, 2005.

<sup>100</sup> About 40% of fabrics would fail the fabric test if most of the approximately 43% of fabric yardage that is predominantly thermoplastic fails and a relatively small percentage of cellulosic fabrics fail. If a greater percentage of fabric yardage requires FR treatment under the industry proposal, associated costs will increase proportionately.

furniture produced (although average costs would be about \$1.00 to \$2.00 per affected item).<sup>101</sup>

Although the industry proposal includes a provision allowing the use of barrier materials with fabrics that fail the 5-second fabric test, the percentage of furniture items that would be made with barriers probably would be very small, since testing has shown that fabrics with high cellulosic fiber content and weight (which tend to be the most cigarette-ignition-prone fabrics) are more likely to pass the test.<sup>102</sup> Therefore, most of the relatively more expensive decorative fabrics (for which a barrier alternative to the 2001 draft standard was requested) could potentially be used without any modifications under the industry proposal.

Manufacturers would also incur lower costs for some filling materials under the industry proposal, compared to the staff's current draft proposed standard. Urethane foam cost increases should be similar to those estimated for the staff's current draft proposed standard, averaging about \$3.41 per item of furniture, with total annual costs of about \$107 million.<sup>103</sup> However, the industry proposal lacks any requirement for polyester fiber used in back cushions, and the cost impact of the proposal on polyester cushioning materials used in seat cushions could be negligible since the quantity of polyester fiber material used on seat cushions, in terms of weight and volume, is relatively small; industry representatives report that non-siliconized polyester would be acceptable for such uses at minimal (if any) cost to the manufacturers. As with the staff's current draft proposed standard, cotton batting currently used by the furniture industry is expected to comply with the industry proposal without modification. The performance of this material may be subjected to closer scrutiny as part of a large scale testing program that is planned for the fall of 2005.

To summarize information on expected costs, it appears that a mandatory rule based on the industry proposal would have lower costs than estimated for the current draft proposed standard. Preliminary estimated annual costs of a standard based on the industry proposal range from about \$139 million to \$153 million, with a midpoint of about \$146 million.<sup>104</sup> This is \$38 million less than the midpoint of the estimated range of costs of the current draft proposed standard (about \$184 million annually).

The expected benefits of the industry proposal are considerably less than estimated for the staff's draft standard. In its assessment of the classification test

---

<sup>101</sup> \$13 to \$26 million annually would average \$.41 to \$.83 per unit for the approximately 31.5 million units produced in a year. However, for the nearly 13 million units that would be made with FR-treated fabrics (40% of the total) per unit costs would range from \$1.03 to \$2.06.

<sup>102</sup> Culp Fabric Corporation, March 1, 2004, comments.

<sup>103</sup> Total estimated costs for FR urethane foam under the staff's draft proposed standard are about \$71 million. These costs are lower than estimated for the industry proposal because of provisions that allow the use of non-complying urethane foam if acceptable barriers are used, including upholstery cover materials that qualify as barriers. As outlined by the industry association in its proposal, all urethane foam used in the production of furniture would require formulation with FR chemicals.

<sup>104</sup> In addition to fabric treatment costs of \$13 to \$26 million and FR urethane costs of \$107 million, total estimated costs include about \$6 million for compliance verification and \$13 to \$14 million in distribution costs.

method proposed by the industry, the CPSC's Directorate for Laboratory Sciences determined that some fabrics which passed the industry test on the basis of slower burn rates produced larger flames than some fabrics that failed the test.<sup>105</sup> The Directorate for Laboratory Sciences concludes from its testing results that, in addition to fabric burn rates, burning intensity and heat generated from the ignited fabric are important factors that affect upholstered furniture flammability and these other factors are not accounted for in the 45 degree fabric test. Further, the Directorate for Laboratory Sciences concludes that a fabric-only flammability test, such as the 45 degree test proposed by the industry, does not represent the flammability behavior of the upholstery fabric when it is covering upholstery filling materials.

Based on the inadequacy of the fabric test in the industry proposal, complying fabrics (including fabrics with FR treatments) are unlikely to contribute substantial benefits in the form of reductions in deaths, injuries, and property damage from furniture fires started by small open flames. The improvement in cigarette ignition performance for treated fabrics is also uncertain, since the FR loadings necessary to pass the 45 degree, 5-second open flame test reportedly are small. Further, since most heavier cellulosic fabrics may pass the proposed industry fabric test without difficulty, the ignition characteristics of fabrics generally shown to present the greatest risk of cigarette-ignited fires would largely not be addressed, since there is no smoldering ignition requirement for fabrics in the industry proposal.<sup>106</sup>

Some benefits could be expected from improved performance of urethane foam used in furniture (the industry proposal recommended that all urethane foam comply with the small open flame requirements of the 2002 draft revision to California TB 117) and polyester fiber used in seat cushions. However, the benefits associated with filling materials are likely to be less than those that would be derived from the staff's current draft standard because the industry proposal lacks requirements for polyester filling materials used in furniture back cushions.

Although there is not sufficient information to estimate the gross benefits of the industry proposal, an evaluation of one class of furniture (items covered with severely cigarette-ignition-prone cellulosic fabrics) strongly suggests that the net benefits of the staff's current draft standard would be substantially higher. As shown in Table 2, about 65 percent (\$505.4 million) of the total estimated cigarette ignition benefits of the staff's current draft proposed standard are expected to result primarily from FR treatment of severely ignition-prone cellulosic fabrics, or the use of acceptable barrier materials. Under the industry proposal, however, FR treatments or barriers would probably not be necessary for such fabrics, and the changes to cushioning materials under the industry

---

<sup>105</sup> Weiyang Tao, Ph.D. "Assessment of fabric Open Flame Test Methodology." Division of Electrical and Flammability Engineering, Directorate for Laboratory Sciences, U.S. Consumer Product Safety Commission. April 14, 2005.

<sup>106</sup> Although the UFAC voluntary program might remain in effect under the industry proposal, the cigarette ignition test for fabric specified by the UFAC program is currently intended to identify fabrics that could not be used over non-FR urethane foam. Since the industry proposal includes a provision that would require FR-treatment of urethane foam, the UFAC fabric test likely would be of no consequence under a standard based on that proposal.

proposal would likely yield a small fraction of the benefits that would result from the CPSC staff's current draft proposed standard for furniture made with these fabrics. Even if improved ignition resistance of urethane foam and other cushion core materials were to achieve 50 percent of the benefits estimated from the staff's current draft proposed standard for furniture made with severely ignition-prone cellulosic fabrics (an estimate that seems unreasonably high in view of the smoldering propensity of these fabrics), total estimated annual benefits would be \$253 million lower than the staff's current draft standard.

Just considering the lower expected cigarette ignition benefits from furniture made with those fabrics, the estimated net benefits of the staff's current draft standard would be \$215 million (*i.e.*, \$253 million - \$38 million) more per year's production than a standard based on the industry proposal. Open flame testing requirements of the staff's draft standard for loose filling materials used with other cellulosic and thermoplastic fabrics should result in an even greater disparity in total benefits compared to a standard based on the industry proposal.

In summary, although it appears that a standard based on the industry proposal outlined in a May 13, 2004, letter to the CPSC could involve annual costs that are about \$38 million less than would be necessary to comply with the CPSC staff's current draft proposed standard, the requirements of the staff's draft standard would more effectively address cigarette and small open flame ignition hazards of upholstered furniture. Preliminary analysis shows that the CPSC staff's current draft proposed standard would result in greater net benefits to society.

### **8.3. Adding Open Flame Performance Testing Requirements for Upholstery Fabrics to the Draft Standard**

The CPSC staff's current draft standard includes cigarette-ignition performance testing requirements for upholstery fabrics, cigarette and small open flame testing requirements for certain filling materials, and optional cigarette and small open flame testing requirements for barrier materials. Also, open flame ignition performance is tested under the alternative requirements for "Type IV upholstered furniture" under the staff's draft standard. The CPSC staff explored the possibility of also developing an open flame test for upholstery fabrics. A test drafted by the staff could subject upholstery fabric covering FR urethane foam to an open flame source for 10 seconds and require the fabric and foam tested in this manner to sustain less than 20 percent mass loss after five minutes. Ideally, the provision would identify fabrics presenting the greatest small open flame fire hazards, and their continued use in the manufacture of furniture would require modifications leading to improved performance or the use of acceptable barrier materials.

In limited testing of 20 different upholstery fabrics, the Directorate for Laboratory Sciences found that a fairly wide range of fabrics resulted in greater than 20

percent mass loss within 5 minutes.<sup>107</sup> Fabrics resulting in failures of the staff's draft fabric test included lighter weight cellulosic fabrics, heavier cellulosic and polyester blends, and olefin fabrics. Passing results were found for four medium-weight cotton fabrics and one nylon fabric.

Open flame testing of these 20 upholstery fabrics, although limited, indicates that a wide variety of fabrics could fail a test based on mass loss. Failing fabrics could include many fabrics that are expected to perform well when subjected to the staff's draft standard's cigarette ignition test for fabrics, including lighter-weight cellulosic fabrics and fabrics made with blends of cellulosic and thermoplastic fibers. With the possible exception of nylon, most of the fabric yardage made with thermoplastic fibers such as polyester and olefin might fail an open flame fabric test based on mass loss. It appears that many of the heavier 100% cotton fabrics that would be classified as moderately and severely cigarette-ignition-prone fabrics could pass the open flame test without modification.

The open flame ignition hazard presented by many of these materials would already be reduced by FR backcoating or incorporation of barrier materials that address the cigarette ignition hazard presented by the fabrics. Furthermore, upholstery cover materials made of leather, wool, and vinyl-coated fabrics generally are inherently resistant to ignition from small open flames, and these materials are also expected to pass the draft open flame fabric test without changes. Therefore, perhaps 50 percent of total upholstery cover yardage would fail the draft open flame upholstery fabric test, based on the limited testing. These fabrics are likely to fall into the material categories of "Moderately Cigarette-Ignition-Prone Cellulosics," "Less Cigarette-Ignition-Prone Cellulosics," and "Thermoplastics." Combined, these categories account for about 59 percent of all cover material yardage used. The estimated 50 percent of fabrics that might fail the draft open flame fabric test would account for 84 percent of all fabric yardage in these three groups. The total remaining societal costs for these fabric groups that might be addressed by an open flame test for upholstery fabrics is \$121.7 million.<sup>108</sup> If the fabrics that would fail the draft open flame fabric test account for 90 percent of the total remaining open flame ignition societal costs for these fabric groups, the average lifetime open flame societal costs that would be addressed by the test would be about \$6.95 per unit ((90% x \$121.7 million)/15.75 million units).

A likely means of compliance with the open flame test would be FR treatment of fabrics. Since the draft fabric test is apparently less severe than that specified in the open flame standard drafted by the CPSC staff in 2001, the required amount of FR

---

<sup>107</sup> Fansler, Linda. Memorandum to Dale Ray, CPSC Project Manager for Upholstered Furniture: "Assessment of Classification Schemes, Performance Criteria, and Standard Materials for the CPSC Staff Draft Upholstered Furniture Flammability Standard." Directorate for Laboratory Sciences, CPSC. May 16, 2005.

<sup>108</sup> This estimate was derived from information shown in Table 4, and is based on the summation of remaining societal costs of about \$10 million from items covered with "Moderately Cigarette Ignition-Prone Cellulosics," \$23.4 million from items covered with "Less Cigarette Ignition-Prone Cellulosic," and \$88.3 million from items covered with "Thermoplastics."

treatment per yard of fabric should be lower (for those fabrics that are treated). While the precise cost of such treatment is unknown, we might assume that the average incremental FR treatment costs would be about 50 percent to 75 percent of the costs estimated for the 2001 draft open flame standard, or about \$5.00 to \$7.50 per furniture unit.<sup>109</sup> On an aggregate basis, these costs would amount to about \$79 million to \$118 million annually (\$5.00 to \$7.50 per unit x 15.75 million units).

Given the above estimate of the per unit lifetime societal costs addressed by the open flame fabric test (\$6.95 per unit of furniture) and the estimated FR treatment costs ranging from \$5.00 to \$7.50 per unit, it is uncertain that the addition of an open flame fabric test provision to the CPSC staff's draft standard would result in an increase in the net benefits of the standard. Even if it adds only \$5 to the costs of treating these fabrics, the additional requirement would have to be more than 70 percent effective at reducing the addressable open flame hazard for the benefits to be greater than or equal to the costs.

It should be noted that the inclusion of this provision might result in an increase of about 20 million pounds of FR chemicals being used annually to treat upholstery cover fabric.<sup>110</sup> Thus, relative to the CPSC staff's current draft proposed standard, this provision would increase substantially the more direct human contact with FR chemicals that would result from its inclusion in cover fabrics.

#### **8.4. Adopting Only the Requirements of the Proposed Draft Standard that Test Smoldering Ignition Performance**

After the staff's current draft standard was presented publicly in May 2005, some industry participants suggested that the standard be limited to the smoldering test requirements. These commenters reasoned that, since the open flame tests for some filling materials present greater difficulties and the cigarette ignition hazard remains the much larger hazard, the open flame test requirements for filling materials should be delayed or eliminated altogether. The purpose of this section is to assess the likely impacts of such an alternative. It should be noted, however, that the smoldering ignition tests of the current draft proposed standard were written under the assumption that the open flame filling materials tests would play a key role in addressing cigarette ignition hazards. Without these open flame tests, more stringent smoldering tests might have been proposed by the staff.

---

<sup>109</sup> Calculated as 50 to 75 percent of the midpoint of the range of estimated FR fabric treatment costs (\$6.61 to \$11.28) plus associated costs of compliance and distribution.

<sup>110</sup> This estimate is based on the assumption that FR chemical loadings required would be about 50 percent of the average required under the 2001 draft standard, and 50 percent (rather than 70 percent) of upholstery yardage would require treatment.

#### 8.4.1. Costs

Based on testing results obtained by the CPSC's Directorate for Laboratory Sciences, commonly-used filling materials such as urethane foam, polyester fiberfill, and boric acid-treated cotton batting are expected to pass the draft smoldering ignition tests.<sup>111</sup> Consequently, the costs associated with the filling material modifications necessary to meet the open flame tests for about two-thirds of furniture production would be eliminated under a smoldering-only alternative.<sup>112</sup> Based on the Section 6.2 and 6.3 results, the costs associated with urethane foam and fibrous filling materials would be reduced by about \$136 million.<sup>113</sup>

The remaining costs of a standard based on the smoldering requirements would mainly be those related to FR-treatment and use of acceptable barrier materials, which have an estimated range of \$33.6 million to \$50.7 million, with a midpoint of \$42.1 million. The only other costs would be those related to compliance verification and distribution, which might amount to about \$6 million.<sup>114</sup> Therefore, the total estimated costs of the draft standard without provisions related to open flame performance of filling materials would be about \$48 million.

#### 8.4.2. Benefits

As noted earlier, existing filling materials already comply with the requirements of the smoldering tests for filling materials. Consequently, without the open flame filling materials tests, the standard would yield no benefits from furniture items covered in fabrics that are neither FR-treated nor used over complying barriers (*i.e.*, fabrics other than "severely cigarette ignition-prone" cellulosic fabrics), since, for these furniture items, filling materials provide the improvement in fire safety under the staff's draft standard.

The expected benefits associated with the use of barrier materials for furniture covered with severely ignition prone cellulosic fabrics will be the same as under the staff's current draft standard, since complying filling materials are not needed for these items under either regulatory alternative. Consequently, the expected lifetime benefits should amount to about \$217.2 million.<sup>115</sup>

---

<sup>111</sup> Fansler, Linda and Scott, Lisa L., Division of Electrical and Flammability Engineering, Directorate for Laboratory Sciences, CPSC, memorandum to Dale R. Ray, CPSC Upholstered Furniture Project Manager, "Performance Criteria, and Standard Materials for the CPSC Staff Draft Upholstered Furniture Flammability Standard," May 18, 2005. Also, Scott, Lisa L., memorandum to Dale R. Ray, "Smoldering and Small Open Flame Ignition Performance of Upholstered Furniture Loose Fill Materials," May 31, 2005.

<sup>112</sup> The only items assumed to require no filling material modifications under the staff's draft proposed standard are those made with complying barrier materials or those covered with upholstery materials that would pass the cover material barrier test.

<sup>113</sup> Comprised of estimated annual urethane costs of \$71 million; fiberfill costs of 50 million; and associated compliance and distribution costs of \$15 million.

<sup>114</sup> About \$4.9 million of these costs are for the 3.25 million units made with FR treated fabrics or barriers and \$4.1 million are for furniture covered with other fabrics and materials.

<sup>115</sup> For the estimated 1.3 million units that will be made with barrier materials under severely ignition prone fabrics, cigarette ignition benefits are assumed to be \$155.48 per unit (\$202.2 million aggregate benefits) and open flame

Benefits will also be derived from furniture items covered with fabrics that are FR-treated to comply with the fabric test of the draft standard. However, the hazard reduction (and, hence, benefits) associated with the use of FR-treated fabric will be somewhat less than under the staff's current draft since the items would not be receiving the contribution of more ignition-resistant filling materials to the overall ignition resistance of the items. Based on the results shown in Table 2, cigarette ignition benefits might amount to about \$74 per unit.<sup>116</sup> Additionally, if open flame ignition hazard reduction of about 50 percent results from FR-fabric treatments, per unit open flame benefits would be about \$6.43 per unit (see Table 4). In the aggregate, these benefits would amount to about \$157.4 million.<sup>117</sup>

Total benefits resulting from FR-treated fabrics and fabrics used over complying barrier materials under a standard that omits open flame testing requirements for filling materials would be about \$375 million.

### 8.4.3. Summary

Based on estimated costs of the draft standard without open flame testing provisions for filling materials of about \$48 million, and estimated aggregate benefits of about \$375 million, net benefits would be about \$327 million. This is about \$425 million lower than net benefits estimated for the current draft standard (about \$752 million).

## 8.5. Adopting Requirements of the Proposed Draft Standard without the Open Flame Provision for Loose Filling Materials

Loose polyester fiberfill ("loose fill") is a common filling material used in loose back cushions of upholstered furniture. It is used in about half of all upholstered furniture items produced; when used, it accounts for roughly 40 percent of the aggregate filling material in the seating area, by weight. While conventional loose fill passes the draft standard's loose fill smoldering test, it does not pass the open flame test without modification. The modification needed to pass the open flame test would likely involve the inclusion of FR fibers or encasement of the loose fill in FR interliners, changes that could, according to some furniture manufacturers, substantially increase the costs of producing and assembling upholstered furniture. The purpose of this section is to evaluate the option of excluding the open flame tests for loose fill from the staff's draft standard.

---

ignition hazard reduction is assumed to be 90% (\$11.57 per unit benefits - - \$15 million aggregate benefits).

<sup>116</sup> Since "moderately cigarette ignition-prone cellulose" pass the staff's draft fabric test, FR-treatments of "severely ignition-prone fabrics" might result in similar expected societal costs per unit. Therefore, as shown in Table 2, lifetime societal costs for FR-treated fabrics are expected to fall from \$194.76 to \$120.44, a reduction of \$74.32 per unit.

<sup>117</sup> Based on 1.95 million units made with FR-treated fabric resulting in about \$12.5 million aggregate lifetime open flame ignition benefits (1.95 million x \$6.43) and \$144.9 million in lifetime cigarette benefits (1.95 million units x \$74.32)

### 8.5.1. Costs of the Loose Fill Requirements

As described in section 6.3, the added manufacturing costs associated with the loose fill requirements average an estimated \$4.88 per furniture item affected. Additionally, taking into account the possible added distribution costs (which, as described in Section 6.5, were assumed to be proportional to the added manufacturing costs), the estimated average costs of the loose fill requirements might add about \$5.37 per affected item. Given that about half of the furniture items with treated filling materials would be produced with loose fill, about 10.3 million furniture units might be affected, at an aggregate cost of about \$55.3 million ( $\$5.37 \times 10.3$  million units).

### 8.5.2. Benefits of the Loose Fill Requirements

The benefits of treating the loose fill<sup>118</sup> would result from the safety enhancement associated with treating all of the filling materials included in furniture items. These benefits could result from retarding fire growth in cases in which the inside back cushion is the initial ignition location, and also from the contribution of the treated loose fill in reducing fire growth when ignition first occurs at other locations.

Estimating the benefits of the loose fill open flame test requirements is difficult because of the lack of data demonstrating the fire-safety contribution of complying filling materials used in specific locations of the furniture items, such as in back cushions where the loose fill is located. However, with regard to open flame ignitions, the available evidence suggests that many serious open flame fires involve back cushions. According to the Directorate for Epidemiology's 1999 analysis, "Small Open Flame Ignitions of Upholstered Furniture," about 63 percent of fires were ignited in the seating area location (which could directly affect the back cushion).<sup>119</sup> Based on this information, it is not unreasonable to assume that the proportion of open flame benefits derived from treated loose fill is equal to the percent (by weight) of the loose fill in the filling materials.<sup>120</sup> As already noted, loose fill is used in about 50 percent of all upholstered furniture items produced, and accounts for about 40 percent of the seating area filling material weight in items in which it is used. Hence, for open flame fires, treating loose fill may account for about 20 percent (*i.e.*, 50% of 40%) of aggregate open flame benefits from furniture items covered with moderately- and less-ignition prone cellulosic and thermoplastic materials (*i.e.*, those without FR treated cover fabrics or barriers), or about \$24.4 million (*i.e.*,  $0.2 \times \$121.7$  million of the Table 4, column 7, benefits). Additional benefits would be derived from furniture items covered with FR-treated cellulosic fabrics (about 2 million units produced with severely cigarette ignition prone cellulosic cover materials), which could bring the total estimated open flame ignition benefits to about \$26.9 million.

---

<sup>118</sup> Either by the inclusion of FR fibers in the loose fill or by encasing the loose fill in FR interliners.

<sup>119</sup> Ault, Kimberly, Ph.D., "Small Open Flame Ignitions of Upholstered Furniture." Division of Hazard Analysis, Directorate for Epidemiology, CPSC, December 6, 1999.

<sup>120</sup> That is, if loose fill accounts for 40% of the treated filling material in a furniture item, then 40% of the benefits associated with treating all of the filling materials will be assumed to be attributable to the loose fill.

While the loose fill requirements directly address open flame ignition performance, they will also provide some additional protection against furniture fires started by cigarette ignition. For example, if other materials used in the furniture allow cigarette ignition to progress to open flame combustion, the presence of treated loose fill in back cushions could retard the growth of the fire. Additionally, treated loose fill could prevent fire ignition from smoldering fabrics that reached the back cushions.

Since the cigarette benefits of treated loose fill are less clear than the open flame benefits, we assume that the proportion of cigarette benefits derived from treated loose fill is equal to half the percent of the loose fill in the filling materials.<sup>121</sup> Based on this assumption, the cigarette benefits of treating loose fill would amount to about 10 percent of the aggregate cigarette benefits from furniture items covered with the moderately- or less-ignition prone cellulosic or thermoplastic fabrics, or about \$27.4 million (*i.e.*,  $0.1 \times \$273.8$  million in the Table 2, column 7, benefits). Some additional benefits would also be derived from furniture items covered with FR-treated cellulosic fabrics having loose fill in backs (an estimated 975,000 units annually). These added benefits could amount to \$15.8 million,<sup>122</sup> and increase the cigarette-related benefits associated with treating the loose fill to \$43.2 million (\$27.4 million + \$15.8 million).

### 8.5.3. Summary

In summary, the estimated costs associated with the loose fill requirements of the staff's draft proposal amount to about \$55.3 million, and the estimated benefits amount to about \$70.1 million (\$26.9 million in open flame benefits and \$43.2 million in cigarette benefits). Consequently, *excluding the loose fill open flame requirements* from the standard would reduce both its costs by \$55.3 million and its benefits by \$70.1 million; net benefits would be reduced by about \$14.8 million (\$70.1 million - \$55.3 million). Overall, the net benefits of the staff's draft proposal, without the loose fill open flame requirements would be about \$737 million annually. This compares to estimated annual net benefits of about \$752 million under the staff's full draft proposal.

Finally, it should be noted that the loose fill cost estimates described in section 6.3. were intended to represent what it would cost today for manufacturers to comply with the loose fill provisions of the standard, given existing materials and existing methods of production and assembly. We believe these costs are likely to come down. The staff is already aware of at least one promising substitute for the conventional loose

---

<sup>121</sup> That is, if loose fill accounts for 40% of the treated filling material in furniture items, then 20% of the benefits associated with treating all of the filling materials in the furniture items will be assumed to be attributable to the loose fill.

<sup>122</sup> This estimate assumes that FR treatment of the severely ignition prone fabrics, without the treatment of filling materials, would reduce the cigarette ignition societal costs to a level equal to that of furniture covered with moderately ignition prone fabrics; complying filling materials would result in a further reduction to a level equal to that of furniture covered with less ignition prone cellulose. Under the loose fill effectiveness assumption described above, the benefits associated with complying loose fill would be an average of 10 percent of the incremental benefits ascribed to all complying filling materials.

fill that would be substantially less costly than the treated loose fill evaluated in this section. Hence, we believe that our cost estimates are probably high, especially over the medium and longer term as manufacturers focus on the least cost solution in addressing the loose fill requirements.

## **8.6. Adoption of a Labeling Rule**

A rule requiring hazard information to be presented on labels could be adopted by the Commission in addition to, or in lieu of, a standard. The costs of labeling would be just a few cents per item (based on reported labeling costs under the UFAC Voluntary Action Program and estimates provided by a manufacturer). However, the impacts of such labeling on product safety are likely to be minimal. Labeling that warns of cigarette ignition hazards is unlikely to be effective, because labels are unlikely to be seen by consumers when the upholstered item is in use, and because there already is general public awareness of these hazards. Additionally, a warning label would not be likely to prevent fires started by children playing with lighters and matches, who are unlikely to read the statements provided.

## **8.7. Effective Date**

Section 4 of the Flammable Fabrics Act states that standards or regulations shall become effective 12 months from the date of promulgation, unless the Commission finds that a different effective date is in the public interest. Because of the need for FR treatment of some fabrics used in the manufacture of furniture and the fact that furniture manufacturers carry stocks of fabrics, a longer period before the rule becomes effective, such as 18 months, could provide some firms additional time to use inventories of fabrics that would not pass the staff's draft standard's fabric test without FR treatment. However, given the small percentage of fabrics that will need to be treated (under 10 percent), it seems unlikely that limiting the effective date to 12 months will substantially burden firms.

Additionally, several options might be available to furniture manufacturers that have fabric that does not comply with a regulatory alternative adopted by the CPSC as the effective date for the action approaches. They might send the remaining fabric yardage to contract finishers for backcoating with FR chemicals. They could use FR barrier materials beneath the untreated fabric, as allowed by that alternative method of compliance with the staff's draft standard. Also, they might sell the fabric to jobbers who would market it to furniture manufacturers that use FR barriers with untreated upholstery fabrics and for other end-uses that are not within the scope of the regulation. In view of the relatively small percentage of fabrics estimated to require FR treatments or other modifications, and other options available to furniture manufacturers, an effective date longer than 12 months from the date of promulgation might not be in the public interest.

Compliance with the staff's draft proposed standard would also require manufacturers and suppliers of urethane foam, polyester fiberfill, cotton batting, and other materials to provide materials that meet the relevant smoldering and open flame material tests so that they would be available for use by furniture manufacturers within 12 months of the date of promulgation of the rule. Current processes and capacities used by the manufacturers of urethane foam and cotton batting to meet mandatory flammability requirements of California and other jurisdictions, and voluntary standards such as the UFAC program, are expected to be adequate to produce sufficient quantities of urethane foam and cotton batting for use by the furniture industry under the staff's draft standard. Additionally, we assume that suppliers of polyester cushioning materials and furniture manufacturers will be able to develop products and processes that will enable the use of polyester-based cushioning materials within that period.

## **8.8. No Action**

The Commission could determine that no rule is reasonably necessary to reduce the risk of fires associated with cigarette and small open-flame ignitions of upholstered furniture. Under this alternative, future societal losses would be determined by factors that affect the likelihood that ignition sources come in contact with upholstery and the ignition resistance of upholstery materials used by furniture manufacturers. For example, the apparently increasing use of ignition-resistant upholstery materials, such as leather, could reduce fires over time. Also, the state of California might adopt the draft revisions to its mandatory standard for upholstered furniture. Those revisions could result in reduced fire losses in that state, which accounts for perhaps 15 percent of the furniture market. Some furniture manufacturers might use materials that comply with some or all provisions of the California revised standard for all of their furniture production, which could reduce fire losses in other areas. Additionally, other political jurisdictions could impose requirements that would reduce future losses from furniture fires.

Factors other than furniture materials will also determine fire losses in the future. Some of these will tend to increase future losses (such as projected annual increases of about 1 percent in population and households) and others might decrease future losses (such as continued reductions in rates of smoking and alcohol consumption, increasing smoke alarm operability, information and education efforts, and installation of sprinkler systems in new construction). Particularly noteworthy might be the availability of cigarettes that reduce the probability of igniting upholstered furniture. Effective on June 28, 2004, the State of New York required all cigarettes sold in the state to self-extinguish if they are left unattended. Such cigarettes are expected to reduce, but not eliminate, residential fires started by cigarettes. Similar legislation has been adopted by Vermont and California (to become effective in 2006 and 2007, respectively). There has also been legislative activity in this area by other states, although legislation has only been enacted by New York, Vermont, and California. We are not aware of

plans by the cigarette industry to expand significantly their marketing of self-extinguishing cigarettes to other areas of the country.

If the Commission does not adopt a mandatory rule to address furniture flammability from both smoldering and open flame ignition sources it is possible that a voluntary standard (perhaps through modifications to the existing UFAC Voluntary Action Program) could be developed based on the CPSC staff's draft standard or based on other provisions, such as those outlined in the May 13, 2004, industry proposal, to address these hazards. However, no such voluntary standard currently exists. Moreover, the effort begun in 1996 through ASTM to establish a voluntary standard is currently inactive. Furthermore, comments submitted in response to the October 23, 2003, ANPR representing all segments of the affected industries supported mandatory federal regulation to address upholstered furniture flammability.

Thus, while furniture fires might decline with no CPSC action, there is no reason to believe that the decline would approach the large proportion of fire losses that could be prevented with the staff's draft proposed standard.