CPSC STAFF BRIEFING PACKAGE ON UPHOLSTERED FURNITURE FLAMMABILITY PRESENTS DRAFT STANDARD, SEEKS PUBLIC MEETING

The U.S. Consumer Product Safety Commission (CPSC) has released an October 2001 CPSC staff document, "Briefing Package on Upholstered Furniture Flammability: Regulatory Options." This package discusses options to address the risk of fire from ignitions of upholstered furniture.

The briefing package presents a draft standard with flammability performance requirements for resistance of upholstered furniture to small open flame ignition sources like lighters, matches and candles. There is no existing nationwide voluntary or mandatory standard addressing this hazard. In 1998, an estimated 420 deaths, 1,080 injuries and $120 million in property damage were attributable to upholstered furniture fires that could be addressed by a standard. Upholstered furniture-related fires account for more residential fire deaths than any other category of consumer products under the Commission's jurisdiction. A disproportionate number of these fire losses, including one-third of the deaths, were to children under age 15.

The CPSC staff has conducted extensive technical research in support of a standard, including: laboratory studies; engineering, statistical and economic analyses; and an assessment of potential health risks associated with flame retardant (FR) chemicals that might be used to meet a standard. Many outside organizations, including industry and fire safety groups, have contributed to these research efforts. The conclusions of the studies and analyses, and the approach the staff is taking in its draft small open flame standard, are presented in the briefing package.

The volume of information in the package and the complexity of the issues led the CPSC staff to conclude that it is important to have a review by interested outside parties before the staff recommends a course of action to the Commission. This staff briefing package recommends that the Commission:

a) share the information in the briefing package with the public; and

b) hold a public meeting to present the CPSC staff's direction and to receive feedback from interested parties.

Copies of this briefing package are available from CPSC's Office of the Secretary, 4330 East-West Highway, Bethesda, MD 20814-4408, or on CPSC's web site, **www.cpsc.gov**. Direct inquiries about the briefing package or about submitting new information may be directed to Mr. Dale R. Ray, Project Manager, tel. 301-504-0962, ext. 1323, or e-mail **dray@cpsc.gov**.

Note: This summary and the staff briefing package have not been reviewed or accepted by the Commission.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
WASHINGTON, DC 20207

Memorandum

DATE: OCT 30 2001

TO: The Commission
Todd A. Stevenson, Acting Secretary

FROM: Stephen Lemberg, Assistant General Counsel[1] SL
Lowell F. Martin, Attorney-Advisor LFM

SUBJECT: Options to Address Small Open Flame Ignition of Upholstered Furniture

VOTE SHEET

Attached is a staff briefing package recommending that the Commission convene a public meeting to present the draft small open flame ignition standard for upholstered furniture developed by staff and solicit comment on it and its supporting documentation from industry, fire safety organizations, and other interested parties. Staff developed the draft standard in response to a petition filed by the National Association of State Fire Marshalls (NASFM) in 1993, petition FP 93-1.

Staff also is recommending that the Commission deny a subsequent petition filed by NASFM (petition 99-1) requesting rulemaking to require flammability warning labels on upholstered furniture containing polyurethane foam.

Please indicate your vote on the following options with respect to these issues.

PUBLIC MEETING ON DRAFT STANDARD

I. Convene a public meeting on the draft small open flame ignition standard for upholstered furniture. OGC will prepare a *Federal Register* notice announcing the meeting for consideration by the Commission.

_____ _____
(Signature) (Date)

[1] This memorandum is forwarded to the Commission by the Assistant General Counsel for Regulatory Affairs because the General Counsel is recused from further involvement in this proceeding.

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Initial rlh Date 10/30/01

II. Do not convene a public meeting on the draft standard.

_____ _____
(Signature) (Date)

III. Take other action (please specify).

_____

_____

_____

_____ _____
(Signature) (Date)

POLYURETHANE FOAM PETITION

I. Deny the polyurethane foam petition, petition FR 99-1. OGC will prepare a denial letter for consideration by the Commission.

_____ _____
(Signature) (Date)

II. Grant the polyurethane foam petition. OGC will prepare an advance notice of proposed rulemaking for consideration by the Commission.

_____ _____
(Signature) (Date)

III. Take other action (please specify).

_____

_____

_____

_____ _____
(Signature) (Date)

Attachment

BRIEFING PACKAGE ON UPHOLSTERED FURNITURE FLAMMABILTY: REGULATORY OPTIONS

October 2001

For further information contact:

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CONTENTS

Section **Page**

Executive Summary

Upholstered furniture fires remain a major U.S. residential fire problem, despite declines in deaths and injuries. The U.S. Consumer Product Safety Commission (CPSC) is considering regulatory options to address the risk from small open flame-ignited furniture fires--a risk that has not declined over time and for which no voluntary standard exists.

Fires in which upholstered furniture was the first item ignited have consistently been a leading killer among all consumer products involved in fires. In 1998, an estimated 420 deaths, 1,080 injuries and $120 million in property damage--a total societal cost of about $2.4 billion--were attributable to upholstered furniture fires that could be addressed by a standard. A disproportionate percentage of these fire losses, including one-third of the deaths, were to children under age 15.

In response to a petition from the National Association of State Fire Marshals (NASFM), CPSC initiated a regulatory proceeding in 1994 to address the risk of furniture ignitions by small open flame sources such as cigarette lighters, matches and candles. These fires caused 80 deaths, 350 injuries and over $30 million in property damage in 1998--a total societal cost of about $500 million. Most small open flame losses, including 60 of the 80 deaths, resulted from childplay fires.

The CPSC staff has drafted a flammability performance standard to reduce the risk to consumers. The standard contains performance requirements for small open flame ignition resistance of seating areas and dust covers of upholstered furniture; it also includes an optional seating barrier test that would allow the use of fire-blocking barriers, or interliners, instead of flame-retardant (FR) cover fabrics. This would give manufacturers flexibility in achieving compliance, and reduce the potential economic burden of the standard, especially for small businesses; it would also preserve consumer choice among many existing upholstery fabrics.

At the direction of the Congress, the National Academy of Sciences (NAS) evaluated 16 FR chemicals that might be used in upholstery fabrics to meet a CPSC flammability standard. NAS identified 8 that would present only minimal health risks, even under extreme conditions of exposure, and recommended further exposure study for the others. A CPSC staff risk assessment concluded that a number of FR chemical treatments are available that would not present health hazards to consumers, although additional data are still needed to determine the potential health effects of other FR chemicals. Expected rulemaking by

the U.S. Environmental Protection Agency would help ensure that no hazardous FR's would be used, and that no significant environmental effects would result. The staff is also working with the National Institute of Occupational Safety and Health to ensure that the health of textile and furniture workers would not be adversely affected.

The volume and complexity of the information developed during the course of this standards development proceeding are substantial. In view of this complexity, the staff recommends that the Commission defer action and share the information in this briefing package with the public before considering proposing a rule. The staff recommends holding a public meeting with interested parties to present the direction of CPSC's draft small open flame standard, to discuss the supporting technical data and to receive comments. This will help ensure full public participation, provide an opportunity for outside groups to present any new studies or other information, and help the Commission determine the need for further action.

The staff further recommends that the Commission deny NASFM petition 99-1 regarding polyurethane foam labeling on the basis that labeling would not effectively reduce the risk to consumers. A small open flame standard may adequately address the risks described in this petition.

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: OCT 30 2001

TO : The Commission
Todd A. Stevenson, Acting Secretary

Through: Stephen Lemberg, Assistant General Counsel SL
Caroline J. Croft, Executive Director CJC

FROM : Ronald L. Medford, Assistant Executive Director for RLM
Hazard Identification & Reduction
Dale R. Ray, Project Manager, EC (301)504-0962 x1323 DRay

SUBJECT: Upholstered Furniture Flammability: Regulatory Options

This briefing package presents information and options related to the risks of upholstered furniture fires. These fires are the leading cause of consumer product-related residential fire deaths in the U.S. The principal furniture fire hazards are from ignitions by a) small open flame sources such as cigarette lighters, matches and candles, and b) smoldering cigarettes.

I. Background

A. Petition for Rulemaking

A 1993 petition from the National Association of State Fire Marshals (NASFM, petition FP 93-1) requested rulemaking under the Flammable Fabrics Act (FFA) to address upholstered furniture fire risks. NASFM suggested adopting existing flammability regulations (known as Technical Bulletins) in the state of California, or other suitable existing regulations.

The Commission granted the petition in part, and issued an advance notice of proposed rulemaking (ANPR) in 1994 on the specific risk of small open flame-ignited fires. The agency's June 15, 1994 ANPR is attached at Tab A. The Commission denied the petition with respect to large open flame-ignited fires, and deferred action on the petition with respect to cigarette-ignited fires pending a CPSC staff evaluation of a) the level of voluntary conformance to existing voluntary industry guidelines, and b) the

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overall level of cigarette ignition resistance among products on the market.

B. Regulatory Development & Analysis

Following the publication of the ANPR, the CPSC staff developed a draft test method to evaluate the small open flame performance of upholstered furniture, and a draft standard containing performance criteria to address the risk. The staff conducted various technical studies to support a possible small open flame standard. The staff also worked to encourage voluntary industry action to address the small open flame risk. In addition, the staff conducted laboratory testing and a market survey to assess cigarette ignitability.

In 1997, the staff forwarded a briefing package to the Commission ("Upholstered Furniture Flammability: Regulatory Options for Small Open Flame & Smoking Material Ignited Fires," October 1997). The staff concluded that a small open flame standard was feasible and could effectively reduce the risk to consumers, including both small open flame and cigarette ignition risks. The staff recommended that the Commission defer action until the agency could gather additional scientific information to ensure that flame retardant (FR) upholstery fabric treatments that manufacturers may use to comply with a flammability standard would not result in adverse health effects to consumers. In view of the likelihood that action to reduce the small open flame risk would also affect the cigarette ignition risk, the staff also recommended that the Commission defer action on the cigarette ignition portion of the petition pending a decision on the small open flame issue.

Since 1997, the staff has continued to develop the small open flame standard. This briefing package presents a draft proposed standard and supporting technical documents, including an assessment of potential health risks associated with the use of FR chemicals.

C. Flame Retardant Chemicals

In 1998, the Commission deferred action on a standard and held a public hearing on FR chemical issues. Representatives of government, industry and fire safety organizations and other interested parties testified at the May 5-6, 1998 public hearing, or submitted information about FR chemicals following the public hearing. Issues raised in these submissions include acute and chronic toxicity of FR compounds, potential consumer and occupational exposure, risk assessment methods, environmental

impacts, costs of environmental controls, and other related topics.

The staff prepared toxicity reviews for 16 individual FR chemicals or chemical classes identified by the Fire Retardant Chemicals Association (FRCA) as candidates for use in upholstery cover fabrics to meet a small open flame standard, and began work on developing exposure and risk estimates for the most likely compounds. The staff incorporated the information submitted pursuant to the public hearing (and all other available scientific data) into its FR chemical risk assessment.

D. FY 1999 Appropriations: NAS Study & GAO Investigation

In the agency's Fiscal Year 1999 appropriation, Congress directed the Commission to sponsor an independent study by the National Academy of Sciences (NAS) of potential health risks from FR chemicals that might be used to meet a flammability standard. CPSC contracted with NAS / National Research Council (NRC) Committee on Toxicology to perform the study. The CPSC staff provided its toxicity reviews and other scientific data to NAS.

NAS delivered its draft report to Congress and to the Commission in April 2000. The final version of the report was published in July 2000.

CPSC's 1999 appropriation also directed the U.S. General Accounting Office (GAO) to investigate CPSC's regulatory development procedures. GAO submitted its report to Congress and to the Commission in November 1999.

GAO's inquiry focused on CPSC's national fire loss estimates. The CPSC staff implemented a number of changes in its fire loss estimation procedure in accordance with GAO's recommendations. The national fire loss estimates in this briefing package reflect this new methodology.

E. Polyurethane Foam Petition

In 1999, NASFM submitted another petition (FP 99-1) requesting that the Commission require labeling under Section 4 of the FFA to warn consumers about the flammability of polyurethane foam used in upholstered furniture. This petition contended that polyurethane foam a) represented a substantial portion of the combustible material contained in upholstered furniture, and b) ignited readily, burned rapidly and generated hazardous amounts of toxic smoke.

NASFM concurrently submitted this petition to the Federal Trade Commission (FTC), contending that failure to warn consumers of the hazard constituted an unfair trade practice under Section 5 of the Federal Trade Commission Act. FTC denied the NASFM petition in 1999, citing CPSC's ongoing rulemaking under the FFA as the most appropriate means of addressing the matter.

F. Petition Withdrawal

In October 2001, NASFM withdrew its petition (FP 93-1) for rulemaking, citing dissatisfaction with the pace of CPSC's activity and the technical direction of the staff's draft small open flame standard. NASFM stated that it intended to submit an amended petition, and requested that the Commission defer action until it could consider the amended petition.

Since the Commission already granted FP 93-1 in part and denied it in part, the petition phase is completed and these parts cannot be withdrawn. The Commission deferred action on the part of the petition requesting action to reduce the risk of cigarette-ignited furniture fires; this part is, therefore, withdrawn.

The issues before the Commission are unchanged. The Commission may proceed or take other action relating to the various furniture fire risks based on the information developed by the staff, irrespective of the existence of a petition. The Commission-directed staff evaluation of the cigarette ignitability of current furniture is complete. If NASFM submits an amended petition, again requesting adoption of California regulations as a national standard, the staff will provide additional information to support a Commission decision on that issue.

G. *Draft Briefing Package Information*

This draft briefing package presents on:

- the status of the small open flame regulatory proceeding;
- the cigarette ignition risk; and
- the 1999 NASFM petition on polyurethane foam labeling.

The package also presents regulatory options and recommendations to the Commission.

II. Fire Hazard Assessment

A. National Fire Loss Estimates

The Directorate for Epidemiology prepared national estimates of losses associated with upholstered furniture fires. These incorporate a new estimation methodology that focuses on fire losses and scenarios most directly addressable by a flammability standard. The furniture fire loss report, attached at Tab B, is an adjunct to the staff's overall report, "1998 Residential Fire Loss Estimates" (issued in March 2001), which also contains furniture fire loss estimates. The estimation procedure in the overall report is more applicable to the broad picture of consumer product-related fires, and slightly different from the procedure used in the furniture-specific report; thus, the estimates in the two reports vary slightly from one another. The estimates used in the staff's analyses for this briefing package are from the furniture-specific report.

1. Data Trends

Fires involving ignitions of upholstered furniture killed more people in 1998 (the latest available data year) than did fires involving any other category of consumer product under the Commission's jurisdiction. During 1998, about 9,400 residential fires involving ignitions of upholstered furniture caused an estimated 480 deaths, 1,340 injuries and $190 million in property damage. The total estimated societal cost of these upholstered furniture fires was $2.8 billion.

Smoking material-ignited furniture fire losses (mostly associated with cigarettes, but also a very small number of cigar and pipe ignitions) significantly outnumber small open flame losses (mostly from ignitions involving lighters, matches and candles). In 1998, there was an estimated total of 340 smoking material-related deaths, compared to a total of 80 for fires ignited by small open flame sources. Estimated societal costs were $1.9 billion for cigarette-ignited furniture fires and $0.5 billion for small open flame-ignited furniture fires.

A significant aspect of the small open flame hazard is the prevalence of childplay fires. Most small open flame-related furniture fire losses, including 60 of the estimated 80 deaths in 1998, were from fires caused by children playing with fire.

A small open flame performance standard for upholstered furniture would address most, but not all, fire losses, including losses from cigarette-ignited fires. These "addressable" losses could be reduced by a standard, depending on its effectiveness.

Addressable losses are shown in bold type in Table 1. Incidents reported through NFIRS were considered "addressable" if they were identified as small open flame ignitions of residential upholstered furniture, and they contained values for several descriptive reporting codes - type of material ignited, area of origin, ignition factor, and equipment involved - that were all consistent with the scope of the proceeding. Fires in which any one or more of the coded categories were out-of-scope or inconsistent were judged "not addressable," even if they were identified as small open flame ignitions of upholstered furniture. These "not addressables" are also shown in Table 1 for reference.

An additional category of "potentially addressable" small open flame losses is included in Table 1. The staff identified a number of fires ignited by sources that appeared to be small open flames, but did not involve lighters, matches or candles. There were almost no fatal fires in this category in 1998, but there were 20 deaths from such fires in 1997. Ignitions by these other heat sources, such as arcs, sparks and embers, could also be addressed by a small open flame standard; in order to maintain the use of conservative estimates, these other ignitions were not used in the staff's analysis of societal benefits of a standard.

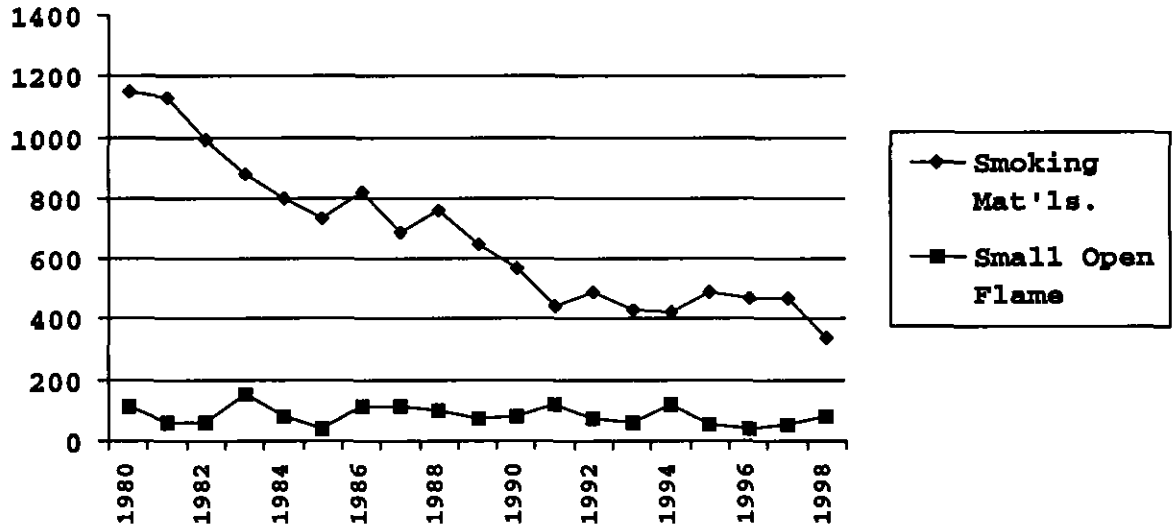
Table 1
Estimated 1998 Addressable[a] Upholstered Furniture Fire Losses

1998 Losses	Fires	Deaths	Injuries	Property Loss (mil)
Total Upholstered Furniture	9,400	480	1,340	$190.8
Total Addressable	**6,200**	**420**	**1,080**	**$119.6**
Smoking-Addressable	**4,700**	**340**	**730**	**$87.4**
Smoking-Not Addressable	200	0*	10	$2.3
Small Open Flame-Addressable	**1,500**	**80**	**350**	**$32.2**
Small Open Flame-Not Addressable	100	0*	10	$1.2
Other Small Flame Sources-Potentially Addressable[b]	**300**	**0***	**20**	**$5.9**
Other Small Flame Sources-Not Addressable	0**	0	0	$0.3
Other Heat Sources-Not Addressable	2,700	50	220	$61.3

[a] Addressable losses are from NFIRS cases identified as upholstered furniture, with appropriate coding for type of material ignited, area of origin, ignition factor, and equipment involved; cases with out-of-scope or inconsistent coding for any one or more of these categories are considered Not Addressable.
[b] Includes sparks, embers or flames escaping from fueled equipment, arcs or sparks from electrical equipment, small torches, hot embers and fireworks.
*Fewer than 5 deaths, rounded to zero.
**Fewer than 50 fires, rounded to zero.
Detail may not add to totals due to rounding.
Source: CPSC / Epidemiology

The staff's statistical analysis of the national fire data shows a significant decrease in the number of furniture fires over the past two decades; for smoking material-related fires (mostly ignited by smoldering cigarettes), deaths and injuries also declined. The 1998 estimates continued this general downward trend, although recent years' data suggest the decline may be leveling off somewhat. There was, however, no accompanying, statistically significant downward trend in small open flame-related deaths or injuries over this time period. The trends in addressable furniture fire deaths (the single most important hazard measure) are depicted in Figure 1.

Figure 1
Addressable Upholstered Furniture Fire Deaths, 1980-1998



Source: CPSC/Epidemiology, based on U.S. Fire Administration/National Fire Incident Reporting System and National Fire Protection Association survey data

2. New Methodology / GAO Recommendations

The 1999 General Accounting Office investigation into CPSC's regulatory development procedures focused on the use of fire loss estimates in the agency's analyses of costs and benefits of a furniture standard. GAO's report, "Consumer Product Safety Commission: Additional Steps Needed to Assess Fire Hazards of Upholstered Furniture," recommended changes in CPSC's approach to estimating fire losses.

The CPSC staff's national fire loss estimate methodology uses data from the U.S. Fire Administration's National Fire Loss Incident Reporting System (NFIRS) and from an annual survey of fire departments conducted by the National Fire Protection Association (NFPA). The staff has been working to improve the precision of its NFIRS/NFPA-based estimates. The staff's 1997 residential fire loss report (published in 2000) incorporated a national estimate methodology that was revised to:

- Eliminate incendiary and suspicious fires, including arson fires (in order to reflect fire losses more likely to be addressed by CPSC actions; and

- Eliminate "unknown" estimates by re-allocating fires of unidentified product-specific codes within the known general furniture category.

These two revisions enable better product-by-product comparisons and strengthen the staff's conclusions about product-related hazards.

In response to the GAO report, the CPSC staff further refined its estimating methodology with more analytical steps specific to upholstered furniture. The staff performed further editing and allocating to eliminate cases that involved furniture ignitions but contained any unknown or uncertain elements. Overall, these additional steps lowered the resulting national fire loss estimates. Therefore, the new method yields a more conservative view of the upholstered furniture fire problem than the previous method.

B. In-Depth Fire Investigations

Since the Commission's 1994 ANPR, the staff has assigned every residential fire reported to CPSC and involving small open flame ignition of upholstered furniture for follow-up investigation by the CPSC Field staff. The staff investigated a total of 206 such fires between October 1994 and July 2001 (the first 76 of these were described in the staff's 1997 briefing package). The in-depth investigations revealed that:

- Childplay fires involving ignitions of upholstered furniture with lighters predominated; match and candle ignitions were also reported.

- The seating area of furniture was most often cited as the ignition location when the location was known; few involved other areas such as dust covers (on the underside

of the article), and none involved skirts (around the bottom edges of the article).

- Fires were started by children as young as 2-3 years of age; most fatalities also occurred among children.

- Childplay fires may often go undetected by adults until the fires grow out of control; most of the investigated fires spread beyond the room of origin.

While the in-depth investigations are not a random sample of furniture fires, they provide a general description of fire characteristics. Directorate for Epidemiology memoranda updating the fire investigation data through mid-2001 appear at Tab B.

C. California Fire Loss Data

An issue raised in the original 1993 NASFM petition was the apparent difference in death rates for residential upholstered furniture fires in California (where mandatory regulations existed) and the rest of the nation. NASFM noted that the California death rate fell by 64% during the 1980's, whereas the rate in the rest of the U.S. declined by only 39%. They conjectured that safer furniture in California explained much of this difference, and asked that the Commission adopt California's regulations as a national standard. California's regulations address both cigarette and open flame risks*.

A 1994 CPSC staff report on this subject essentially confirmed the lower California death rates. However, a cause and effect relationship could not be established; the principal California standard at issue (Technical Bulletin 117) had only been in effect for a few years and the California furniture fire death rate already appeared to be more than 4 times lower than the national (non-California) rate. NASFM sponsored a statistical analysis concluding that if the overall U.S. death rate were the same as California's, there would have been around 500 fewer furniture fire deaths annually during that time period.

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*The current version of California's Technical Bulletin (TB) 117 contains *component* performance and labeling provisions addressing risks of cigarette and small open flame ignition; TB-117 is mandatory for all upholstered furniture sold in the state (see Section III.E for additional discussion on this standard). TB-116, which includes *composite* cigarette ignition performance and labeling provisions, is voluntary. TB-133, a more stringent standard with *full-scale,* large open flame requirements, applies to furniture used in specific non-residential occupancies not protected by automatic sprinklers.

The Directorate for Epidemiology staff prepared an updated memorandum on this issue; this memorandum appears at Tab B. The staff compared California and national furniture fire death rates over time since 1980, correcting for some non-reporting in the California and national fire reporting systems; these corrections reduced the differences between the two. They reanalyzed the estimates to evaluate the statistical significance of the two trends. They concluded that the 1980 California death rates, both overall and for cigarette-ignited fires, were still significantly lower than the 49-state rates. They also concluded that the rates of decline between the death rates in California and the other 49 states were significantly different. They noted, however, that the California rate could probably not be achieved nationwide by adopting the California standards alone, because:

- The California death rate was about half the national rate by 1980, long before any beneficial impact of TB-117 would likely be observed (TB-117 became effective in 1976; the voluntary TB-116 did not add product performance requirements, and the non-residential TB-133 did not exist);

- Other existing demographic factors more likely explained the rate trend difference, most particularly smoking prevalence, which declined much faster in California than in the rest of the U.S. during the 1980's (this may have also affected small open flame ignitions involving lighters and matches, as these products are more often found in smoking households); and

- In CPSC's flammability tests, the cigarette and small open flame performance of California TB-117-compliant chairs (made with flame retardant filling materials) was essentially no better than chairs meeting existing UFAC voluntary guidelines.

The staff concludes that, while California has a significantly lower furniture fire death rate than the rest of the nation, implementing California's existing standards would not adequately address the risk to consumers. It should also be noted that the California Bureau of Home Furnishings and Thermal Insulation, which administers the state's flammability regulations, is currently revising and updating TB-117 to improve its effectiveness. This update project is discussed further in Section III.C, below.

III. Small Open Flame Standard Development

A. CPSC Staff Standard & Test Method

The CPSC staff developed a draft small open flame standard for upholstered furniture. This standard includes protocols for three flammability tests applicable to two locations on a finished article of furniture where small open flame ignitions may occur. A seating area test and a dust cover test evaluate the propensity of furniture to ignite and continue to burn when exposed to a small open flame source (the staff also designed and built an electromechanical test fixture and apparatus for use with these tests). An optional seating barrier test evaluates the resistance of furniture constructed with fire-blocking barriers to a larger open flame source.

The seating tests in the draft standard are "hybrid" component tests that evaluate composite mockup performance by varying individual components in the tests. While full-scale tests of finished articles of upholstered furniture would best characterize flammability performance, full-scale tests of every model of every product would be unnecessarily duplicative and burdensome. On the other hand, component-only tests may not adequately reflect the performance of the components in composite assemblies. Small scale, true composite tests using all of the actual materials in the finished article can also predict full-scale performance, but are still costly. Under the staff's draft standard, actual composites are permitted, but not required. The tests in the draft standard adequately reflect the performance of the finished article without imposing unreasonable technical or cost burdens.

The overall goal in developing the draft standard was to address the types of fire incidents associated with small open flame ignitions of upholstered furniture. These are chiefly childplay incidents that may progress before adults become aware of the fires; victims are often also young children. Therefore, a major objective was to achieve ignition resistance, i.e., limiting the early stages of fire growth that precede spread of the fire to the interior materials of the furniture or to other nearby combustibles in the home. The small open flame tests and acceptance (pass/fail) criteria in the draft standard focus directly on this objective. The seating area requirements address the risk for the most frequently observed furniture ignition location. The dust cover requirements address the risk of ignition involving the exposed area under the seat that is vulnerable to ignition from beneath.

The staff's review of studies on the burning behavior of upholstery materials showed that ignition of upholstered furniture results in either or both flaming and smoldering combustion. While the relationship between flaming and smoldering combustion is complex, and some aspects of ignition and fire growth are not well understood, it is clear that either or both of these combustion modes may result from either an open flame ignition or a cigarette ignition. The draft small open flame performance standard evaluates the kind of burning behavior that could be expected from either source. CPSC laboratory tests indicate that most products meeting the requirements of the draft standard would exhibit significantly reduced small open flame and cigarette ignitability. This experimental evidence supports the discussion of the potential safety benefits of a standard (see Section III.G, below).

The seating area small open flame test would require that a mockup of cover fabric and standard polyurethane foam (or any other upholstery materials chosen for use in the finished article of furniture) resist continued combustion--flaming, glowing or smoldering--beyond specified times after a 20 second exposure to a 35 millimeter flame applied in the crevice of the mockup. The mockup must also not burn to any edge during this time. This test relies largely on the ability of the cover fabric to "self-extinguish," thereby limiting the growth of the fire in its initial stages and preventing involvement of interior filling materials or nearby combustibles.

Similarly, the dust cover test, for furniture so equipped, would require that the dust cover material (in this case, a horizontal sample) not continue to burn after a 20 second small flame exposure. The test specimen must also not burn to any edge. This prohibits the use of dust cover fabrics that would contribute to a fire started on the underside of a piece of furniture.

The first draft of the standard, without a seating barrier test option, was included in the staff's 1997 briefing package. The staff made two principal revisions since the previous version of the draft standard was published. The first change lengthens the post-ignition smoldering / glowing combustion time observation period in each test from 2 minutes to 15 minutes (test specimens that are essentially consumed or produce dripping and sustained floor fires within the observation period are still considered unacceptable). This recognizes the distinction between the more immediate threat of flaming ignition and the relatively less immediate threat of smoldering ignition, and provides observation time to evaluate whether the furniture composite would continue to support combustion. The change would also permit more fabrics to be used, and would reduce the potential variability of seating

area test results for some fabrics exhibiting "borderline" flammability performance without compromising safety.

The second change adds the seating barrier test as an alternative to the seating area test. This test was adapted from British Standard BS-5852, as referenced in the U.K. Regulations. The seating barrier test would require that a mockup of barrier material and standard polyurethane foam resist continued combustion beyond specified times following exposure to a small (40 millimeter square base, 60 millimeters high) wood "crib" ignition source that simulates burning fabric. Dripping, charring and flaming would also be limited. This test measures the barrier's ability to self-extinguish without significant involvement of filling materials.

At the manufacturer's option, upholstered furniture may achieve compliance by meeting either the seating area test or the seating barrier test. Fire-blocking barriers were developed to reduce heat release and toxic smoke production from burning items; however, barriers can also provide flame spread and cigarette ignition protection, depending on the characteristics of the cover and barrier fabrics and interior materials. The alternate test, which was requested by furniture and fabric manufacturers, would allow products to be made with suitable barriers that provide fire protection by preventing involvement of filling materials after exposure to a larger flame source than the one used in the seating area test. The availability of this alternative to the small open flame seating area test gives manufacturers flexibility in materials selection, and preserves consumer choice among upholstery cover fabrics.

Both the seating area and barrier tests are conceptually similar to provisions of the existing U.K. furniture regulations. While the tests are not identical, most products that comply with the U.K. regulations would be expected to meet the requirements of the CPSC staff's draft standard. A significant difference is that the U.K. Regulations allow non-match-resistant fabrics of 75% or greater natural fiber content (e.g., cotton, rayon, viscose, silk) to be used with approved barriers. A manufacturer's decision to use barriers, however, is not based only on fiber content; allowing barrier use only with natural-fiber fabrics would be unduly restrictive. The CPSC staff's draft standard does not tie the use of barriers to any specific fabrics; it affords flexibility of compliance methods to manufacturers while still providing adequate consumer safety.

Table 2 summarizes the performance provisions of the standard.

Table 2
CPSC Small Open Flame Standard Performance Requirements

Test	Ignition Source	Maximum Flaming	Maximum Smoldering/Glowing
Seating area	Small butane Flame, 20 sec.	2 min.*	15 min.
Alternate Seating barrier	U.K. (BS 5852) Crib #5	10 min.	60 min.**
Dust cover	Small butane Flame, 20 sec.	2 min.*	15 min.

* with no burning to any edge of the test specimen
** with limited spread of combustion of foam filling material, no dripping, and no uncontrolled flaming

In order to provide guidance to manufacturers, the staff also incorporated a sampling plan for a multi-tiered set of tests to establish compliance with the draft standard. This plan is conceptually similar to the plan in CPSC's Children's Sleepwear Regulations (16 CFR 1615 & 1616). Without such a plan, manufacturers could unfairly be considered non-compliant on the basis of a single failing test that may not be representative of fabric or barrier material production. The staff believes it is essential to incorporate reasonable sampling provisions into the draft standard to minimize uncertainty among firms subject to the standard, and to enforce a standard effectively.

There are three levels in the sampling plan: *Initial Sampling* of products for which compliance is undetermined; *Normal Sampling* for products consistently passing the initial sampling tests; and *Reduced Sampling* for products consistently passing the normal sampling tests.

- In *Initial Sampling*, the specified test is performed on 4 test specimens from each of 3 sample locations, i.e., 12 tests altogether, on a "production unit," defined as continuous yardage of at least 50 and up to 1,000 linear yards of material. This may include color or print variations of the same fabric, or similar fabrics with equivalent flammability characteristics. A failure among any of the 3 samples would require additional tests to ascertain the acceptability of the production unit. More than one test specimen failure would reject the production unit. After 5 passing production units, normal sampling would apply.

- In *Normal Sampling*, the testing scheme is similar to initial sampling, but much less frequent; testing is performed on 2 samples from production units of up to 5,000 linear yards. If a production unit is rejected, testing reverts to the

initial sampling scheme. After 5 passing production units, reduced sampling would apply.

- In *Reduced Sampling*, testing of consistently complying material is even less frequent; testing is performed on 2 samples from production units of up to 10,000 linear yards. If a production unit is rejected, testing reverts to the initial sampling scheme.

The sampling plan would offer some flexibility to manufacturers who opt, for example, to have multiple runs of similar fabrics tested together as a single production unit. The plan would require that records be kept for each production unit. This would allow the common U.K. practice of seaming together short runs of many different fabrics from different manufacturers in a single production unit for testing; however, each fabric manufacturer would be liable for any production unit failure. These short runs of fabric may range from a few hundred linear yards down to as little as 5-10 linear yards for custom designs.

Since testing short runs would be costly and destructive, and since production runs of less than 50 linear yards would not be required to be tested, most firms would probably opt not to test short runs. Such fabrics could instead be used in upholstered furniture with complying barriers. Barriers would tend to be produced in larger quantities and could be more efficiently tested by their suppliers. Other materials, like individual leather hides, could also be considered short runs, and would not have to be tested. This likely effect is reflected in the staff's estimates of the cost of the draft standard in the preliminary regulatory analysis (see Section III.G, below).

The draft standard also contains record-keeping requirements to help manufacturers and importers identify sources of fabrics or other materials used to meet the standard. The complete draft small open flame standard, with supporting documentation prepared by CPSC's Directorates for Engineering Sciences and Laboratory Sciences, appears at Tab C.

B. Flammability Testing

The CPSC Directorate for Laboratory Sciences has conducted a number of studies to examine the small open flame performance of upholstered furniture and its components. In the 1997 briefing package, the staff reported that upholstery cover fabrics were the primary determinant of small open flame ignition behavior; filling materials, which can greatly affect cigarette ignitability, are less important in small open flame ignition resistance. Most current U.S. furniture--even California furniture made with flame

retardant foam filling materials--will ignite and burn when exposed to a small open flame.

The staff's preliminary 1997 evaluation indicated that various flame retardant fabric treatments would effectively reduce the risk of small open flame ignition and fire growth. FR fabrics are the likely method of choice for most fabrics to meet the seating area test in the staff's standard, although a few upholstery cover materials (most notably leather) need not be FR-treated. Testing also indicated that small open flame-resistant FR fabrics would generally remain resistant to cigarette ignition; this included some cellulosic fabrics that would otherwise be prone to cigarette ignition.

Since the Commission's 1998 decision to defer action, the staff has carried out additional laboratory testing to build on the previous information on the small open flame performance and cigarette ignitability of fabrics and furniture. The staff:

- tested a variety of upholstery cover fabrics intended to provide resistance to small open flame ignition;
- obtained and tested finished chairs designed and constructed to offer small open flame resistance; these chairs were purchased from sources in the United Kingdom, and ostensibly met the U.K. Regulations;
- tested some new types of fire-blocking barrier materials in addition to those tested previously;
- assessed the sensitivity of small open flame resistance to 14 different test variables (e.g., protocol variations, fabric durability effects, and the role of filling materials);
- conducted additional interlaboratory studies of the test method in the standard; and
- further examined the cigarette/open flame ignition relationship.

The laboratory testing summary report and supporting memos appear at Tab D. Much of the testing and analysis was conducted when the small open flame acceptance criteria for seating areas in the draft standard included a 2-minute maximum for all forms of combustion after flame exposure. The current 15-minute time period for smoldering and glowing would have a minor effect on the overall results: some borderline fabrics previously considered unacceptable may now be acceptable under this provision. This would not reduce the potential benefits of the draft standard. Similarly, some barriers were tested only to the small open flame seating area test; however, most were tested to the alternate seating barrier test after that test was developed.

1. Fabric Testing

Between 1997 and 2000, the CPSC Laboratory staff conducted small open flame tests on 50 different fabrics, from various U.S. and foreign sources. Included were 34 fabrics made with either FR chemical treatments or inherently fire resistant fibers; these fabrics were expected or purported to offer improved small open flame resistance. Of the 34 FR fabrics, 11 that were FR backcoated were also available in non-FR form for testing as control samples.

Seating area mockup tests confirmed that upholstery cover fabrics with FR treatments or made with inherently FR fibers provide significantly improved small open flame resistance. Table 3 presents the overall test results by fabric characteristics and "pass/fail" results under the 2-minute maximum combustion acceptance criteria of the draft standard. (Note: under the revised draft standard allowing 2 minutes of flaming and 15 minutes of non-progressive smoldering or glowing, at least 1 of the 5 "failing" fabrics would have performed acceptably). The CPSC Laboratory staff also conducted experiments, on passing fabrics, with extended flame application times of 35-120 seconds instead of the 20 seconds specified in the draft standard. These additional results are shown in the far-right column of the table.

Table 3
Upholstery Fabric Small Open Flame Mockup Performance

		Small Open Flame Performance		
Fabric	# Samples	Pass*	Fail	Pass > 20sec
All fabrics	50	29	21	20
FR-treated:				
Total	24	19	5	16
Backcoated	16	11	5	8
Immersion	8	8	0	8
Inherent FR**	10	8	2	4
Non-FR	16	2	14	N/T

* No ignitions in multiple flame applications
** Made with predominantly polyvinyl chloride or FR polyester fiber
N/T = Not Tested
Source: CPSC / Laboratory Sciences

About 79% (27 of 34) of the FR-treated or inherently FR-fiber fabrics tested met the draft standard's small open flame resistance criteria for seating areas, i.e., they self-extinguished without burning to the edge of the test specimen. Only 2 of the tested non-FR fabrics passed. About 74% (20 of 27) of the passing FR fabrics also performed well when exposed to extended flame application times, suggesting that they provide a significant margin of safety. The staff concluded that the use of FR fabrics would effectively reduce the small open flame risk.

The staff identified some "borderline" fabrics that, even with FR treatment, performed inconsistently in seating mockup tests. Sometimes these fabrics exhibited acceptable small flame resistance, but in other tests the same test specimen ignited and burned. Similar results were obtained in industry-sponsored small open flame tests. The staff identified some factors that may affect this phenomenon, including fabric / treatment compatibility, variability in the amount of FR chemical present, and the physical characteristics of the fabrics themselves. The principal observed variability, however, involved the inherent physical characteristics of the fabrics themselves. The revised provisions allowing 15 (instead of 2) minutes of smoldering, and allowing barriers would tend to reduce this variability. Based on CPSC's testing experience, the staff believes the test protocol in the standard can adequately distinguish borderline fabrics, and can be used to evaluate flammability performance.

2. Full-Scale Testing / Bench-Scale Correlation: U.K. Chairs

To build on the promising initial results of the fabric tests, the staff tested chairs constructed with FR fabrics. The staff used these tests to examine the relationship between small-scale test results obtained using the seating area mockup procedure and the performance of full-scale, finished articles of furniture made to resist small open flame ignition. Since residential furniture with FR fabrics was not available in the U.S., the staff obtained chairs, covered with a variety of fabric types, from U.K. manufacturers. The staff specified that the chairs comply with the U.K. Regulations, and be constructed with FR fabrics (none had barriers).

The staff tested a total of 27 U.K. chairs. Following full-scale small open flame and cigarette tests on each chair, the staff disassembled the chairs for seating area mockup tests. The staff also conducted cigarette mockup tests, when enough fabric was available.

Twenty-one of the 27 chairs had no ignitions in multiple trials) in small open flame mockup tests. Sufficient yardage of 22 of the U.K. chair fabrics was available for FR vs. non-FR foam comparisons. From the testing, the staff concluded:

- the bench-scale small open flame mockup test correlated with full scale results in most (20 out of 22) cases, with statistically significant agreement of the test results;

- some of the chairs probably did not comply with the U.K. Regulations; low FR chemical concentrations (one chair had no

FR fabric treatment at all) were evident in several fabrics in poor-performing seating mockups;

- filling materials did not affect small open flame ignitability of most FR fabrics (there was no statistically significant difference between the FR vs. non-FR foam mockup results); and

- most chairs that resisted small open flame ignition also resisted cigarette ignition; filling materials, fabric fiber content, construction and weight all affect cigarette ignitability (also see Subsection 5 below).

The CPSC staff conducted a statistical analysis of the full scale results for the U.K. chairs and the results of past studies of small open flame ignitability. The analysis showed that complying U.K. chairs were significantly less ignitable than existing U.S. chairs; the analysis was used in establishing the likely range of potential safety benefits associated with the staff's draft standard (see Section III.G, below).

The CPSC staff also analyzed the correlation between the full scale and mockup tests done with the U.K. chairs and component materials. The analysis showed consistency of test performance, and demonstrated positive correlation between full- and bench-scale results. This indicates that composite mockups that meet the test criteria would perform similarly to the actual finished article of furniture. Small open flame and cigarette test results were also positively (though not significantly) correlated.

3. Barrier Testing

The staff also conducted limited testing on a small group of fire-blocking barriers—also known as "interliners"--designed to be placed between the cover fabric and the filling materials; certain barrier fabrics can also be laminated to the back of cover fabrics. Some of the tested barriers were made with aramid, melamine or glass fibers. The staff also tested some "active" barriers with intumescent FR chemistry; the intumescent material swells when exposed to the heat of a fire, thereby causing the burning cover fabric to self-extinguish.

Initially, the staff tested barrier/fabric/foam mockups using the small open flame ignition seating test protocol in the draft standard. In these 2-minute combustion time tests, barriers sometimes caused the mockups to self-extinguish, but did not do so consistently. In most cases, the cover fabrics ignited and continued to burn until consumed; some barrier manufacturers speculated that small flame-ignited fires may not generate

sufficient heat in their early stages to activate the intumescent chemistry of some active barriers. Some of the passive and active barriers protected the foam filling materials from becoming involved in the fire, but they did not perform consistently.

During the development of the alternate seating barrier test in 2001, the staff obtained additional samples of barrier materials from U.K. and U.S. sources. These included FR-treated cotton barriers used in some U.K. upholstered furniture, and some current and experimental synthetic materials. Some barrier manufacturers, who are evaluating the market potential for such products, donated materials to the agency for testing.

The CPSC laboratory tested most of the available barrier materials using the alternate test (described in Section III.A), in which a barrier/foam seating mockup is exposed to a burning wood "crib," and the ability of the barrier to prevent continued fire growth is measured. The staff conducted crib tests on barrier-equipped mockups, with and without cover fabrics, and with and without pre-conditioning (soaked and unsoaked). The staff also conducted small open flame and cigarette ignition tests. The staff performed limited exploratory crib tests using a representative set of 6 different thermoplastic and cellulosic cover fabrics. These cover fabrics exhibited little variability, indicating that a single configuration would adequately characterize barrier performance. The exploratory testing also suggested that using a conventional cover fabric in mockups subject to the crib test was unreasonably stringent.

In the U.K. barrier test mockup, a standard, lightweight FR-treated polyester fabric covers the barrier. The CPSC staff obtained some of this standard test cover fabric, and found that the fabric typically melted away when impinged by the test flame. The FR cover fabric had no apparent effect on the performance of most barriers, although some barriers performed worse with the FR cover fabric (the significance of this is uncertain, given the limited number of samples available for testing). The staff concluded that a plain mockup (i.e., barrier and foam only, no cover fabric) would provide a sufficiently severe test of the barrier materials.

Table 4 presents the crib test results for the barrier materials. The table shows flaming time and total time to self-extinguishment, as well as the pass/fail rating for each.

Table 4
Seating Barrier Open Flame Test Results[a]

Barrier Material	Pass/Fail[b]	Comments
A 100% FR cotton*	Fail	Obvious ignitions - 5 tests
B 100% FR cotton	Fail	Obvious ignitions - 5 tests
C 100% FR cotton	Fail	Obvious ignitions - 4 of 5
D 100% aramid	--	Used in experimental tests only
E 100% aramid	Variable	No ignitions - 2 of 3
F melamine/aramid	Pass	No ignitions - 3 tests
G melamine/aramid	Pass	No ignitions - 3 tests
H 100% novoloid	Pass	No ignition - 1 test
I 100% novoloid	Pass	No ignition - 1 test
J 100% novoloid	Pass	No ignition - 1 test
K melamine/aramid/ polyester	Pass	No ignitions - 3 tests
L melamine/aramid/ polyester	Pass	No ignitions - 3 tests

[a] Crib tests of barrier / foam seating mockups; data for cotton barrier fabrics A, B and C are for pre-conditioned (soaked) samples; others were unsoaked
[b] Passing combustion time limits: 10 min. flaming, 60 min. total
*Note: chemical analysis revealed no FR treatment present in barrier A
Source: CPSC / Laboratory Sciences

To estimate the relative severity of the crib test, the staff also conducted small open flame tests using conventional cover fabrics and the standard U.K. FR fabric, plus a plain (no cover fabric) mockup. In some tests with conventional cover fabrics, the cover fabrics ignited and essentially burned completely away, but the barrier protected the foam within. These results--technically failures of the small open flame seating test--were expected, since the barriers were passive designs not intended to cause the cover fabrics to self-extinguish. The small open flame tests demonstrated that the crib test is an appropriately more severe ignition source for use with the alternate seating barrier test.

The staff concluded from the open flame barrier testing that:

- Fire-blocking barriers are currently available that would provide adequate filling material protection from flaming ignition;

- Most complying barriers would be suitable for use with a wide range of non-FR cover fabrics; and

- The crib test adequately evaluates barrier performance, and no standard cover fabric is needed.

The staff also tested the cigarette ignition resistance of barriers with a variety of non-FR cover fabrics. These tests are discussed in Subsection B.6.c, below).

4. Sensitivity Testing

During the development of the seating area test, numerous issues were raised about the sensitivity of the staff's test protocol and fixture design to various factors. These included variations in certain elements of the test method itself as well as external effects (e.g., wear, cleaning and soiling) on test fabric durability, and the role of filling materials. These issues impact the likely effectiveness of the standard. The staff performed sensitivity studies for 14 seating area test variables that could affect flammability test results. Table 5 presents an overview of the results of these tests. The staff also evaluated effects on FR chemical migration (see section III.F).

Table 5
Small Open Flame Sensitivity Testing Results

Variable	Effect?
Fixture seat back angles	No
Flame angle	No (not variable*)
Flame placement	No
Flame size	No
Flame application time	No (not variable*)
Fabric tension	No
Soaking procedure	No
Filling materials (FR vs. non-FR)	Possible (very few fabrics)
Spilled liquids	No
Soiling	No
Cleaning and wear	No
Consumer-applied fabric finishes	No
Fire barriers (small flame seating test)	Yes (but inconsistent)
Borderline FR fabrics	Yes (inherent in fabric)

*These elements are fixed when the automated test apparatus is used.

The staff concluded that these variables are well controlled under the existing test method and fixture specifications. Filling materials can affect performance in some cases with certain borderline fabrics, but these tests and subsequent U.K. chair tests suggest that any such effect is minimal. The draft standard allows the actual seating area materials (fabrics and fillings) to be tested as an alternative to the specified

standard, non-FR foam (with specified modifications to the test fixture). Combined with the other revisions to the seating area test discussed above (i.e., the lengthened allowable smoldering time, and the barrier test option), this would allow manufacturers significant flexibility in mockup testing.

5. Interlaboratory Testing

One of the staff's goals in preparing the standard was to develop a feasible test method and fixture that a) could reasonably be used by industry, b) yielded consistent results among production runs of the same materials, and c) could achieve comparable results when performed by different test laboratories. The staff conducted two interlaboratory studies (commonly referred to as "Round Robin" tests) in which CPSC and other labs conducted the same tests on identical fabric / foam samples.

The first Round Robin, conducted in 1996 and described in the staff's October 1997 briefing package, was a preliminary study designed to establish the general feasibility of the test method and to identify problems and suggest potential improvements. Three outside laboratories participated with the CPSC laboratory in this study. While the staff concluded that the test method was generally sound, several improvements were subsequently made (including a substantial redesign of the fixtures for portability, precision and user-friendliness), largely in response to a variety of technical concerns expressed by the participants.

To achieve the staff's goal of a consistent, reliable test method, CPSC sponsored a second, more comprehensive interlaboratory study, conducted during 1999-2000. This study was designed to examine the consistency and precision of the revised draft test method, with respect to both repeatability (or *within-lab* variability) and reproducibility (*between-lab* variability) of test results.

Nine laboratories, including the CPSC Laboratory, participated in the study. The labs represented a cross section of stakeholders in CPSC's regulatory development proceeding, including industry, academic and government organizations. The CPSC laboratory staff provided samples of 5 test fabrics (some FR-treated, some not), standard foam, and test fixtures to each participant. The staff also made training available to participants at the CPSC lab. A staff member visited each participating lab at the start of its respective round of testing.

The test data showed consistent results overall, within and between laboratories. For the seating area tests, the fabric expected to "fail" the test did so in all labs in all tests. The fabrics expected to "pass" the test did so in over 96% of all

tests. The fabrics expected to yield mixed results (due to their inherent ignition performance variability) exhibited the expected inconsistency. The dust cover test results were identical for 8 of the labs (data from the ninth lab may be similar but conclusions could not be drawn from the data submitted).

The CPSC staff performed a statistical analysis, in accordance with ASTM guidelines, of the test results. Consistency statistics were computed for each combination of the 5 tested seating fabrics and 9 laboratories to measure the relationship between the test results for each fabric or laboratory and the results for all laboratories. The analysis concluded that the test data exhibited consistent results within and between laboratories.

Precision statistics for repeatability and reproducibility were also computed for each fabric in all labs to measure the degree to which similar test results may be obtained under similar conditions. The analysis indicated that these statistics were within acceptable limits for the method to be used in a standard. The staff's subsequent refinements to various provisions of the standard (as described above in section III.A) would tend to reduce the variability observed in the interlaboratory study.

6. Cigarette Ignitability of FR Fabrics

To assess the cigarette ignition resistance of upholstered furniture made with FR fabrics, the CPSC Laboratory staff conducted cigarette tests on the U.K. chairs. The staff also tested some materials that were claimed to be small open flame resistant, in addition to those in the U.K. chairs. Most (but not all) of these chairs and materials would meet the performance provisions of the draft small open flame standard.

a. U.K. Chairs

Among the fabrics covering the 21 U.K. chairs that performed acceptably in the seating area mockup test, 14 were predominantly cellulosic; some of these would be considered more prone to smoldering ignition from cigarettes in non-FR form. The other 7 were predominantly thermoplastic fabrics that would be considered less prone to smoldering ignition in non-FR form.

The staff tested the cigarette ignition resistance of these fabrics using mockups with non-FR polyurethane foam (the U.K. chairs had FR foam, but this would not likely affect the results, since non-FR foam is generally cigarette resistant). Table 6 presents the cigarette test results for the U.K. chairs.

Table 6
Cigarette Ignition Resistance of U.K. Chairs With Complying FR Fabrics

Fabric Type	Total # Small Open Flame Resistant[a]	Cigarette Resistant[b]	
		#	%
Predominantly Cellulosic	14	11	79
Predominantly Thermoplastic	7	7	100

[a]Seating area mockup "passed" small open flame test
[b]No ignitions from any of 7-11 burning cigarettes placed at various locations on each chair
Source: CPSC / Laboratory Sciences

As shown in the table, 18 of the 21 "passing"-fabric chairs, including 11 of the 14 cellulosics and all 7 of the thermoplastics, also resisted cigarette ignition in the staff's full-scale tests.

The staff performed a statistical analysis of the experimental data for the U.K. chairs and fabrics meeting the draft small open flame seating area test. These data were compared to similar, full-scale test data for currently available U.S. chairs. The analysis demonstrated that the small open flame standard would also reduce cigarette ignitions; the effect is highly statistically significant. This indicates that the observed 79% and 100% reductions in cigarette ignitability for predominantly cellulosic and predominantly thermoplastic fabric-covered chairs are a true result of using FR fabrics. This strongly suggests that FR fabrics can be used to meet the staff's draft small open flame standard and also provide improved cigarette ignition resistance. The staff used the ignitability data from the U.K. chair tests to estimate the potential benefits of the draft standard (see Section III.G, below).

b. Additional Fabrics

Prior to the cigarette ignition tests performed on the U.K. chairs discussed above, the staff conducted cigarette ignition tests on a variety of FR and non-FR fabrics obtained at different times from a variety of sources. This testing was primarily in response to industry concerns that FR treatments would worsen the performance of many cigarette-resistant fabrics.

The staff performed mockup tests using a total of 40 (21 FR + 19 non-FR) fabrics. Sixteen of the 21 FR fabrics were available both with and without FR treatment: 11 paired sets with and

without FR backcoatings, and 5 paired sets with and without FR laminates (i.e., separate FR backing layers glued to the reverse of the fabric). Most of the non-FR fabrics were thermoplastics or blends; these were expected to be cigarette ignition-resistant.

The staff performed cigarette tests using two different mockup test methods: the Upholstered Furniture Action Council (UFAC) Fabric Classification Test Method and a CPSC-modified version of the UFAC procedure using CPSC's small open flame seating area mockup. Most of the fabrics were tested using both methods. A somewhat greater number of FR fabrics were tested using the CPSC method, due to fabric supply limitations. The two different mockup test methods yielded consistent results.

In the staff's testing of the 40 additional fabrics:

- 34 of the 40 fabrics resisted cigarette ignition; 6 cotton fabrics, including 3 FR-backcoated fabrics, ignited from one or more cigarettes using either the UFAC or CPSC method.

- Most (17 of 20 under the CPSC method, and 16 of 16 under the UFAC method) seating mockups using FR fabrics designed to be small open flame resistant also resisted cigarette ignition.

- Among the 16 pairs of FR and non-FR control fabrics, all mockups with FR fabrics that would meet the CPSC draft standard were at least as cigarette resistant as their non-FR counterparts. Of the 3 FR fabric mockups that ignited from cigarettes under the CPSC method, 2 appeared to display reversals (i.e., ignited from cigarettes only after FR treatment). However, mockups using these 2 fabrics did not pass the CPSC staff small open flame test, so they would not be used (except perhaps with barriers). The single FR fabric mockup that passed the small open flame test and ignited from cigarettes - the undesirable outcome - also ignited from cigarettes (and was *not* small open flame resistant) in its non-FR form. Thus, this fabric's cigarette performance did not worsen with FR treatment.

The results of the additional fabric mockup tests are an indicator of cigarette ignition resistance, to the extent that the flammability characteristics of the tested materials reflect the performance of the finished article of furniture. While the mockup tests were not performed on a representative sample of furniture fabrics, the test data show no evidence that the standard would worsen the cigarette ignition risk. As discussed earlier, there is evidence that FR fabrics would offer improved cigarette resistance.

c. Barriers

As a part of the program to evaluate the performance of fire-blocking barriers, the CPSC staff tested the cigarette ignition resistance of seating mockups made with the 12 available barrier materials. The barrier materials that met the alternate seating barrier open flame test generally performed well in cigarette tests. Mockups using one of the test fabrics, a 100% cotton corduroy, ignited from a cigarette in at least one trial when tested with two of the complying barriers; all other combinations had no ignitions in multiple trials. Based on these limited data, the staff believes that upholstered furniture made with complying fire-blocking barriers would provide significant cigarette ignition resistance as well as open flame resistance.

C. California TB-117 Update

The state of California promulgated the only mandatory standard in the U.S. for residential upholstered furniture in 1975. It became effective in 1976, and applies to all upholstered furniture sold in the state. The California regulation mandates the provisions of Technical Bulletin 117, a test standard containing both cigarette and small open flame component requirements. TB-117's small open flame requirements are adapted from CPSC's clothing textiles standard (16 CFR 1610). This is considered to be a minimal standard; in CPSC's tests, complying California chairs--made with conventional fabrics over flame retardant filling materials--ignited and burned about as readily as non-California chairs when exposed to a small open flame source.

In October 1999, the Bureau of Home Furnishings and Thermal Insulation (BHF, of the California Office of Consumer Affairs), which enforces the state's flammability regulations, announced a new project to update and revise TB-117. BHF sent letters to known stakeholders, including CPSC, inviting submission of data and comments. The CPSC staff corresponded and met with BHF staff on several occasions, and suggested that BHF consider composite ignition tests that would address childplay fires, the principal small open flame scenario. Copies of the initial correspondence between CPSC and BHF appear at Tab E.

At several flammability conferences in 2001, BHF representatives reported on the status of the TB-117 update project. A BHF statement summarizing their activities also appears at Tab E. Based on their research, BHF plans to propose substantive small open flame-related amendments, including a possible composite seating area test that could lead to the use of FR fabrics or fire-blocking barriers, as well as strengthened

component tests (e.g., requirements for more effective FR filling materials). These amendments may be proposed as soon as early 2002. Industry groups are vitally interested in BHF's actions; many firms already specify TB-117 for all of their products marketed nationwide, and would likely continue to do so. The proposed TB-117 amendments and the CPSC staff's draft standard may not contain all of the same performance requirements, but it appears the two efforts may lead to similar levels of safety improvements, and similar effects on the evolution of upholstery materials and constructions. It is likely that items produced to meet a revised TB-117 would incorporate most of the components needed to meet the CPSC staff's standard, the exception being that all furniture sold in California may continue to use FR filling materials.

The CPSC staff has benefited significantly from BHF's research and technical expertise. The staff will continue to work cooperatively with BHF on technical issues, monitor the progress of the TB-117 update project, and harmonize provisions of TB-117 and the CPSC staff's draft standard to the extent possible.

D. Voluntary Standards Activities

After the Commission published its ANPR, no one submitted a statement of intent to develop or modify a voluntary standard addressing the small open flame ignition risk pursuant to section 4(g)(6) of the FFA. The staff is aware, however, of ongoing voluntary activities that could lead to a voluntary standard.

The staff's 1997 briefing package discussed the activities of an ASTM E5.15 Furnishings and Contents Subcommittee work group. The subcommittee established this work group in January 1996 to develop a small open flame test method for use in an ASTM voluntary standard. The work group included trade association representatives of all the major industry stakeholders. The group reviewed existing methods, including those in the U.K. Regulations and the CPSC staff's standard. Work group members conducted tests using the CPSC staff's method and fixtures, met with CPSC technical staff, and discussed progress and data provided by CPSC at regular quarterly ASTM subcommittee meetings. Some of these members participated in the CPSC-sponsored interlaboratory studies. The ASTM work group has not arrived at a consensus regarding a small open flame test method suitable for proposal in an ASTM standard.

In mid-2000, various industry representatives formed an intra-industry furniture coalition to investigate possible new small open flame-related initiatives. The coalition included:

--The Upholstered Furniture Action Council (UFAC)
--The American Furniture Manufacturers Association (AFMA)
--The Alliance for the Polyurethanes Industry (API)
--The American Textile Manufacturers Institute (ATMI)
--The Polyurethane Foam Association (PFA)
--The American Fiber Manufacturers Association (AFMA)
--Cotton, Incorporated
--The National Cotton Council (NCC)

In August 2000, UFAC issued a "Mission Statement on Upholstered Furniture Flammability," supporting the coalition's "research that could result in an upholstery product that would be more resistant to open flame as well as cigarette ignition." Also in August 2000, API (an arm of the American Plastics Council, and formerly the Polyurethanes Division of the Society for the Plastics Industry) issued a "Position Statement on Residential Upholstered Furniture and Mattress Fire Performance," supporting a joint industry effort to address furniture and mattress flammability. The API statement favored "the adoption of a national standard by a government authority" to reduce fire risks. In February 2001, ATMI also issued a "Policy Statement on Residential Upholstered Furniture Flammability," supporting work toward a standard that takes into consideration the combinations of component materials in furniture, and allows continued consumer choice of upholstery fabrics. In May 2001, PFA also issued a "Position Statement on Residential Furniture and Mattress Flammability," supporting research to identify a composite test method and possible component performance standard that suppliers could use to certify products. The UFAC, API, ATMI and PFA statements appear at Tab F.

In late 2000, the intra-industry furniture coalition established a Small Open Flame Technical Committee (SOFTC) to develop a small open flame test method. This group developed a test plan, began testing using a method based on weight loss, reviewed CPSC interlaboratory and hazard data, and participated in the California Bureau of Home Furnishings' effort to revise California Technical Bulletin 117. UFAC communicated with the CPSC staff about these activities; their letter is also included at Tab F. The first phase of an interlaboratory study of the SOFTC test method, conducted in 2001, reportedly resulted in some revisions to the SOFTC test method. SOFTC's work to complete this effort, which could form the technical basis for an ASTM or other standard, is ongoing. The overall goal of this effort is to develop a composite test method and standard that measures flammability performance by means of requirements for individual components. This approach is conceptually similar to the approach taken by the CPSC staff and by the California BHF.

A September 2001 API-sponsored laboratory study reported that a weight loss-based small open flame test method was suitable for

a wide variety of furniture composites. This study found, as did CPSC, that components (fabrics and foams) complying with California TB-117 did not resist small open flames in mockup assemblies. The API study also found that FR foam meeting the more stringent "crib 5" specifications in BS-5852 ignited in small open flame mockups with conventional (non-FR) fabrics. API recommended using composite tests as the most reliable basis for evaluating the small open flame performance of upholstered furniture.

Since 1999, the CPSC staff has communicated or met with representatives of several companies and industry organizations regarding new technical innovations that may be applicable to a new small open flame standard, either for mattresses or upholstered furniture. These are chiefly FR fabric treatments or inherently FR fibers for use in cover fabrics or fire-blocking barriers. As discussed in Section III.B above, some of these new products performed well in CPSC laboratory tests. Manufacturers may introduce and further develop these products if they believe that a significant market for them exists.

There is no voluntary standard or test method yet in effect addressing the small open flame risk. If the Commission proposed a small open flame rule, the staff would evaluate any voluntary standard as to technical adequacy and likely industry conformance, in accordance with the procedural requirements of the FFA.

E. International Activities

There has been increasing international interest in upholstered furniture flammability over the past decade, since the U.K. issued mandatory regulations and the U.S. initiated a regulatory proceeding. European Union member nations have considered mandatory or voluntary measures. The staff has been monitoring these developments, and has also communicated with government representatives from Canada, Australia, New Zealand, France and Hong Kong.

The U.K. Ministry of Health's Department of Trade and Industry (DTI), which administers the U.K. Regulations, sponsored a study on the effectiveness of the regulations. The report on this study ("Effectiveness of The Furniture and Furnishings (Fires)(Safety) Regulations of 1988," University of Surrey, 2000) concluded that the U.K. rates of furniture fire deaths and injuries declined significantly during the first 10 years after the regulations were promulgated.

DTI is currently sponsoring additional work regarding flame retardant chemical issues. A previous DTI-sponsored study (Risks and Benefits in the Use of Flame Retardants in Consumer Products,"

University of Surrey, 1999) found no evidence of significant FR product-related risks to consumers, and projected substantial benefits for FR use in upholstered furniture. Another, earlier U.K. Institute of Occupational Medicine report ("A Cross Sectional Study of Skin Complaints and Respiratory Symptoms in Workers in the Furniture Upholstery Industry," 1993) found minor acute health effects (e.g., dermatitis, conjunctivitis, and rhinitis) in some furniture workers. These effects were largely attributed to the use of FR chemicals.

The Organization for International Standards (ISO) published voluntary standards for upholstered furniture flammability, essentially based on the U.K.-referenced tests, in 1988 following issuance of the U.K. regulations. These are ISO 8191-1 (cigarette ignition) and ISO 8191-2 (small open flame ignition). In 1993, the European Committee for Standardization (CEN) published analogous standards, EN 1021-1 and EN 1021-2. The European Union has considered but not adopted these as mandatory, harmonized standards. A draft EU Directive implementing these two standards has not been enacted, in part due to economic and FR chemical concerns.

The CPSC staff reviewed a draft EU-sponsored chemical risk assessment on one bromine-based FR compound; the report concluded that consumer exposure was likely to be negligible, but that exposure data were limited. In September 2001, the European Commission announced a proposal to phase out various brominated FRs, including penat-, octa- and decabromodiphenyl oxides. The two higher-bromine compounds were included as a "precautionary" measure, based on evidence that they are persistent and bioaccumulative, pending the outcome of the EU risk assessment.

In 2000, the French government proposed mandating EN1021-1 for residential furniture, with EN1021-2 optional, or voluntary, plus mandatory match resistance labeling. EN1021-2 was proposed as mandatory for public occupancy furniture, with additional mass loss / time criteria (from a proposed weight loss standard, EN1021-3) for furniture used in "high risk" occupancies.

Representatives of these foreign governments have been monitoring the progress of CPSC and California BHF activities, and are aware of the NAS study findings. The staff has no information to suggest that any other nations will promulgate upholstered furniture safety regulations in the near future; however, CPSC action may have some impact on international standards activities. The CPSC staff's standard is similar in many respects to the U.K. Regulations and the ISO and CEN standards.

F. Flame Retardant Chemicals

While some upholstery cover materials, like leather, vinyl-coated fabrics and certain wool fabrics, generally do not ignite when exposed to a small open flame, most fabrics ignite and continue to burn. Flame retardant filling materials generally will not resist ignition once the cover fabric is burning. Thus, flame retardant fabrics or FR barriers that resist ignition or self-extinguish would likely be used to meet the CPSC staff's draft standard. Furniture and textile manufacturers reported that they would, for the majority of products, choose to use FR treated cover fabrics over other flame resistance options such as fire-blocking barriers or interliners, or fabrics made from inherently FR fibers. FR-treated fabrics would be an especially likely choice for the price-sensitive mass market. FR barriers would likely be used with difficult-to-treat fabrics, especially decorative or other higher-priced fabrics.

FR textile technology has long been established in other applications, including residential upholstered furniture sold in the U.K. FR treatments, typically applied in post-production steps along with soil release agents, rinses or other fabric finishes, are generally of two types: a) latex or acrylic emulsion backcoating, heat-bonded to the reverse side of the fabric; or b) liquid treatment, by either immersion or surface treatment. FR barriers may be FR-treated cotton, or inherently-FR aramid, melamine or glass fiber fabrics that are installed between cover fabrics and filling materials.

The CPSC staff has been studying the scientific data on FR chemicals to ensure that a possible flammability standard would not present health risks to consumers. In 1998, reflecting concerns about a lack of data for a number of FR compounds, the Commission deferred action on a standard and held a public hearing to gather information on FR chemical issues, including toxicity, potential consumer and occupational exposure and risk, environmental impacts and economic costs of possible FR chemical controls. CPSC's March 17, 1998 *Federal Register* notice soliciting information on these issues is attached at Tab G.

1. Public Hearing Comments

The Commission held a two-day public hearing on May 5-6, 1998 on FR chemical toxicity issues. Twenty-one individuals, including representatives of U.S. and foreign government agencies, industry groups, academic and other scientific institutions, and fire safety organizations testified at the hearing. Thirty-seven others also submitted post-hearing written comments, studies, unpublished scientific data or other information. At CPSC's request, the Fire Retardant Chemicals Association (FRCA)

identified 16 FR compounds or chemical classes most likely to be used in fabric treatments. Copies of the 421-page hearing transcript and the post-hearing submissions were forwarded previously to the Commission, and are available from CPSC's Office of the Secretary.

The public hearing provided an opportunity for CPSC to gather additional information on FR chemicals. The staff analyzed the public comments submitted at or after the public hearing. The principal issues raised in the public comments are discussed below.

Issue: FR Chemical Toxicity and Exposure

Several commenters asserted that many FR chemicals were toxic, and that consumers could be exposed by reasonably foreseeable use, including normal wear, cleaning, or childplay, and would be at increased risk for various chronic health effects. A number of commenters cited a lack of toxicity data for certain FRs. A few furniture and textile industry commenters specifically questioned assumptions and conclusions in the staff's toxicity report in the 1997 briefing package. Other, opposing commenters--generally chemical manufacturers--presented information indicating that various compounds are not chronically toxic, are durable, or could be used safely in fabric finishes.

The staff agrees that many candidate FRs are toxic, as defined in the FHSA and the Commission's chronic hazard guidelines, and that exposure data are lacking for a number of these compounds. The staff has, however, developed or received a substantial amount of information beyond that available before the public hearing. The latest available toxicity data were incorporated into the National Academy of Sciences (NAS) report (discussed in Section III.F.2, below). The staff prepared toxicity reviews that were shared with NAS and used as a basis for the CPSC staff's risk assessment.

The 1997 staff report on FR toxicity was a preliminary evaluation of available data on a few FRs that the staff considered possible candidates for use. Because there was limited information available on many of the FR chemicals being considered, the staff recommended additional study before considering further regulatory action. The staff risk assessment in this briefing package was prepared with the benefit of considerably more data than were available in 1997.

Issue: Risk Assessment Methods

Some commenters noted that CPSC had presented no consistent method of evaluating chemical risks. They recommended that CPSC

adopt uniform risk assessment and "approval" methods and guidance to manufacturers and users of FRs.

The FHSA and the Commission's Chronic Hazard Guidelines outline the considerations for evaluating chemical hazards. Consistent evaluation criteria were applied in assessing each of the major FR chemicals. The CPSC staff's overall approach was similar to NAS's, in that the risk assessment took into account all available data, and, when necessary and appropriate to compensate for a lack of data, used a number of conservative assumptions (i.e., that tend to overestimate the hazard) in modeling exposure and risk. In addition to CPSC's analysis, possible EPA rulemaking will help ensure that hazardous or environmentally undesirable FR chemicals are not used in upholstered furniture to meet a flammability performance standard.

Issue: Worker Health Effects

Some industry commenters alleged that workers in furniture and textile manufacturing facilities would be exposed to hazardous chemicals if CPSC issued a flammability standard. Other, opposing commenters stated that FR textile usage had been studied and found not to present occupational risks.

Although the Commission does not regulate occupational risks, the staff considered possible worker exposure to FR fabrics. At CPSC's request, the National Institute for Occupational Safety and Health (NIOSH) has undertaken a worker health hazard evaluation study to assess potential occupational risks. This study is discussed further in Section III.F.4, below. NIOSH has reported that it is unlikely that FR chemical use in upholstery fabrics would present significant worker health risks.

Issue: Antimony Trioxide and SIDS

One commenter discussed the alleged connection between one of the listed candidate FRs, antimony trioxide (AT), and Sudden Infant Death Syndrome (SIDS). This issue was first publicized in the 1970's after some SIDS deaths in the U.K. were blamed on antimony-containing FR treatments in crib mattresses.

Panels of scientific experts in the U.K. and the U.S have extensively studied a possible causative relationship between antimony and SIDS. These peer-reviewed scientific studies do not support such a causative relationship. The CPSC staff concurs with this assessment.

2. NAS Chemical Risk Study

In CPSC's 1999 appropriation, Congress directed the Commission to contract with the National Academy of Sciences, National Research Council Committee on Toxicology to conduct an independent study of potential health risks associated with the use of FR chemicals to meet a possible CPSC flammability performance standard. Congress appropriated $500,000 for this study, which was to be completed within 12 months. CPSC was prohibited from issuing any notice of proposed rulemaking on upholstered furniture before considering the NAS study findings.

NAS initiated work in January 1999, and selected a subcommittee of experts in toxicology, risk assessment and related fields to perform the study. CPSC's Directorate for Health Sciences staff managed the NAS contract and provided scientific data and documents to the subcommittee.

The subcommittee reviewed toxicity and exposure data on the 16 FR chemicals or chemical classes identified by the FRCA as likely candidates for use. Exposure data were generally limited or not available. Thus, the subcommittee used very conservative assumptions in their estimates of consumer exposure. NAS noted that this approach tended to overestimate the potential exposure and risk to consumers; the actual risk would probably be lower than that estimated by the subcommittee. In addition, the subcommittee based its assessment of certain FR chemical classes on surrogate compounds; these were often the most toxic chemicals in the class. Thus, for several reasons, the NAS risk assessment tended to overestimate potential risks.

NAS submitted a draft report to Congress and to CPSC in April 2000; the final report, "Toxicological Risks of Selected Flame Retardant Chemicals," was published in July 2000. The NAS report concluded that 8 of the 16 FR chemicals reviewed would present a minimal risk, even under worst case assumptions about exposure. These were:

- Decabromodiphenyl oxide
- Hexabromocyclododecane
- Phosphonic acid, (3-{[hydroxymethyl]amino}-3-oxopropyl)-, dimethyl ester
- Tetrakis (hydroxymethyl) phosphonium salts (chloride salt)
- Zinc borate
- Alumina trihydrate
- Magnesium hydroxide
- Ammonium polyphosphates

Additional exposure studies were recommended for the remaining 8 chemicals. These were:

- Antimony trioxide
- Tris (monochloropropyl)phosphate
- Tris (1,3-dichloropropyl-2)phosphate
- Calcium and zinc molybdates
- Antimony pentoxide and sodium antimonates
- Chlorinated paraffins
- Aromatic phosphate plasticizers (tricresyl phosphate)
- Organic phosphonates (dimethyl phosphonate)

A brief CPSC statement summarizing the NAS report is attached at Tab G.

3. EPA Regulatory Activity

Representatives of the U.S. Environmental Protection Agency's Office of Prevention, Pesticides and Toxic Substances testified at the CPSC's 1998 public hearing. They described EPA's authority under the Toxic Substances Control Act (TSCA) to regulate FR chemical risks, and offered to assist CPSC in determining whether any controls may be needed to limit the use of any FR chemicals that may be used to meet a CPSC flammability standard.

Among EPA's regulatory tools under TSCA are Section 5(a)(2) Significant New Use Rules (SNUR's), which would require *manufacturers, importers or processors of existing chemicals to* notify EPA of their intent to distribute existing chemicals for specific new end uses at least 90 days prior to such activity. EPA may, upon evaluation of chemical hazard information submitted in a Significant New Use Notification (SNUN), determine that additional rulemaking (e.g., to require testing, or to prohibit use) is necessary. TSCA already requires firms to report when they introduce new chemical substances. EPA outlined the SNUR procedures in a July 12, 1999 letter to CPSC; the letter appears at Tab H.

CPSC and EPA established a joint staff working group to cooperate in the respective agencies' activities on upholstered furniture. EPA is developing a draft SNUR that could be proposed as a companion to any CPSC regulation. A SNUR is a proposal-and-comment rulemaking procedure; however, the SNUR becomes effective retroactively to its proposal date. In their letter of February 26, 2001 to CPSC (also attached at Tab H), EPA noted that their life cycle environmental review would encompass manufacturing, processing, use and disposal; EPA would consider industrial,

occupational, residential, environmental, and general public exposures in determining the need for any action.

The existence of a SNUR would help CPSC and EPA ensure that FR chemicals used to meet a CPSC flammability standard for upholstered furniture would not present unreasonable risks to the public. To assist EPA in developing the SNUR, the CPSC staff prepared a priority ranking of FR chemicals, summarizing the available toxicity data, the NAS report and the CPSC staff risk assessment. The Directorate for Health Sciences memorandum on this subject is included at Tab H.

4. NIOSH Worker Health Study

When it deferred action on upholstered furniture in 1998, the Commission expressed concern not only about possible health risks to consumers, but also about whether increased FR chemical use might adversely impact the health of workers in furniture and textile manufacturing and processing facilities. Some industry representatives echoed this concern at the 1998 public hearing, citing a lack of information on occupational exposures in those industry sectors. The issue was also raised in Congressional correspondence with CPSC, and in comments to the NAS subcommittee. The NAS report focused on potential health risks to consumers from household furniture use, and did not consider potential occupational health effects.

At the CPSC staff's request, the Hazard Evaluations and Technical Assistance Branch of the National Institute of Occupational Safety and Health undertook a Health Hazard Evaluation study of the principal identified FR chemicals. The HHE study involved two basic phases: developing sampling and analytical methods for detecting and measuring FR chemical exposure, and data collection and voluntary inspections of manufacturing facilities where FR fabric treatments are processed or handled. Since FR fabrics are not currently used in U.S. residential furniture production, the study focused on the limited FR use in business and industrial furniture (e.g., for products meeting California TB-133) and in fabrics destined for export to Europe.

NIOSH reported on their progress and preliminary conclusions from the HHE study (their February 15, 2001 letter to CPSC appears at Tab H). They generally found the potential for exposure, by either dermal or inhalation routes, to be low. They noted that workplace controls are already in place to minimize such exposures. *NIOSH preliminarily concluded that increased FR usage* in the quantities envisioned would not pose significant risks to workers involved in fabric finishing or handling. NIOSH plans to

conduct further testing and evaluation to document this preliminary conclusion.

5. CPSC Staff Risk Assessment

Under the Federal Hazardous Substances Act (FHSA), whether a substance is "hazardous" depends not only on toxicity, but also on dose-response, exposure and risk. The Directorate for Health Sciences evaluated potential FR chemical health effects by considering each of these elements. The staff risk assessment report and supporting documents appear at Tab G.

a. Hazard Identification & Dose-Response Assessment

The first aspect of the staff's FR chemical evaluation was a review of available data on the acute and chronic toxicity of compounds identified as potential fabric treatment candidates. The Directorate for Health Sciences prepared reviews for each of the 16 FR compounds or classes identified by the FRCA.

The staff reviewed all available information on acute and chronic toxicity. Chronic effects include carcinogenic, neurological, and reproductive or developmental effects as well as any systemic (e.g., liver or kidney) effects. The staff calculated acceptable daily intake (ADI) values for chronically toxic compounds; upholstered furniture containing FR chemicals designated as toxic and presenting potential exposure exceeding the ADI could be considered "hazardous" under the FHSA. The toxicity reviews were released to the public and presented at NAS subcommittee public meetings in 1999. The staff subsequently updated the toxicity reviews to reflect the latest available data (as of December 2000), including toxicity data presented in the NAS report and in UK and EU risk assessment reports.

Thirty-seven compounds comprised the 16 reviewed chemical categories. Twenty of these 37 compounds would be considered "toxic" under the FHSA, based on sufficient evidence in animals or limited evidence in humans. The staff's exhaustive review revealed that some data gaps continue to exist: for example, not all of the chemicals have been tested for carcinogenicity, teratogenicity or neurotoxicity. The remaining 17 compounds did not satisfy the definition of "toxic" under the FHSA; however, only limited data were available for those FRs.

The toxicity reviews reflect the fact that many commercially useful chemicals -- even those with health or safety benefits -- may, in large enough doses, be acutely or chronically toxic in humans. They do not present health risks, however, unless exposure occurs and the body is able to absorb sufficient quantities to produce the toxic effect.

b. Exposure Assessment

The second part of the staff's analysis was to estimate potential exposure to FR chemicals from treated furniture fabrics. Much of the information used in this assessment was developed specifically for the Commission's upholstered furniture project; exposure data for these FR chemical fabric applications were generally limited because very few upholstery fabrics were available with any of the FR treatments of interest.

Since upholstery fabric applications do not yet exist for many of the 16 potential-use chemical classes reported by the FRCA, the staff identified and selected for review 8 compounds with existing applications or for which reasonable exposure estimates could be made. These 8 compounds were already in use in furniture (e.g., in U.K. fabrics or California filling materials), or were reported by manufacturers as highly likely to be used in fabrics to meet a small open flame standard, or were of greatest concern among the candidate FRs. It should be noted that these 8 compounds were not the same as either group of 8 ("minimal risk" or "further study") chemicals listed in the 2000 NAS report; the 8 compounds considered by the CPSC staff comprise some of each of these two groups.

To perform the assessment, the staff evaluated data for dermal and oral routes of exposure, and used mathematical models to estimate possible inhalation exposure (since inhalation exposure data were generally lacking). The staff analysis also considered bioavailability and dose-response data for adults and children, and considered the effect of FR chemical application methods on potential exposure.

Data on the ability of FR chemicals to migrate from treated fabrics were unavailable for some of the 8 FR chemicals considered. For these compounds, the staff used surrogate data from closely related compounds to estimate chemical release and exposure. The staff also made reasonable assumptions about skin absorption of compounds for which data were unavailable. Exposure routes and scenarios included the following:

Route	Scenario
Dermal	Passive exposures: Normal use Fabric exposed to spills* Fabric exposed to cleaners* Active exposures**: Spills Fabric spot cleaning
Oral	Mouthing (children)
Inhalation	Vapor phase (off-gassing) Particle emissions

*fabrics previously exposed to spills or cleaners
**consumers directly exposed to spills or cleaners

The CPSC Laboratory conducted migration tests on samples of fabrics with 4 FR chemicals currently in use in the U.K.: antimony trioxide (AT), decabromodiphenyl oxide (DBDPO), hexabromocyclododecane (HBCD), and phosphonic acid (PA). Migration tests were also conducted on fabric samples containing a fifth chemical, tetrakis (hydroxymethyl) phosphonium chloride (THPC), which is considered a candidate for cotton upholstery fabrics. The staff obtained samples of the 5 available FR-treated fabrics, and measured the amounts of FR chemicals that migrated from the fabrics into liquids under various conditions. Other experiments simulated the mouthing action of young children. The staff also studied the effect on migration of exposing fabrics to environmental conditions such as wear, filtered sunlight and heat.

The laboratory staff first measured total FR content in fabric samples. This was done either by a) digesting the fabric in nitric acid and measuring elemental antimony or phosphorus by inductively coupled plasma spectometry (for AT, PA and THPC), or b) extracting DBDPO with tetrahydrofuran or HBCD with acetonitrile and analyzing the extract by high pressure liquid chromatography.

The staff then used two methods it developed for measuring chemical migration from upholstery fabrics into liquid media:

- To estimate *dermal exposure*, the staff measured migration to filter paper placed on multiple samples of each fabric and saturated with solvent (either saline, citric acid, a water-based upholstery cleaner, or methyl chloroform).

- To estimate *oral exposure*, e.g., from children mouthing fabrics, the staff used a "head-over-heels" method in which fabric samples were placed in bottles of saline solution and rotated by a special apparatus at 60 revolutions per minute for 30 minutes.

In addition, the staff estimated *inhalation exposure* using a mass-balance model to predict the concentration of FR chemicals in indoor air. This model considers air exchange rates, room volumes and other factors; it is similar to the model used in the NAS study of FR chemicals.

The staff also investigated the effects of age and wear on FR-treated fabrics. At least one sample of each fabric was subjected to accelerated aging (heat and light) and then subjected to the migration tests described above. Fabrics with AT and DBDPO were also subjected to accelerated mechanical wear through cycles of pounding and abrasion.

In general, the staff found migration to be low for these compounds; for several parameters, some or all of the migration measurements were below the limit of detection. In the case of THPC and PA, the staff observed some migration of phosphorus-containing compounds, but the chemical form that was released could not be identified.

The staff estimated exposure for three additional chemicals used in related (fabric or foam) applications: cyclic phosphonate ester (CPE, one of the compounds in the organic phosphonates class); 2-ethylhexyl diphenyl phosphate (EHDP, one of the aromatic phosphate plasticizers); and tris (1,3-dichloropropyl) phosphate (TDCP). To estimate exposure for these FRs, the staff used data for surrogate compounds or industry data for other fabrics.

To ascertain the dermal bioavailability of FR compounds, CPSC worked with the U.S. Environmental Protection Agency's National Health Effects and Environmental Research Laboratory (NHEERL) under an interagency agreement to conduct a percutaneous absorption study. This study measured the amount of DBDPO, HBCD and TDCP absorbed by skin excised from laboratory animals. The study found that TDCP was readily absorbed through the skin; however, the two brominated FRs (DBDPO and HBCD) were absorbed at a relatively low rate. The EPA report is available from the CPSC Office of the Secretary; the staff memo summarizing the results is included at Tab G.

c. Risk Assessment

Using the data on hazard assessment and dose-response from the toxicity reviews, and data from the exposure studies, the

staff evaluated the risks to consumers associated with the use of 8 candidate FR chemicals either most likely to be used or of greatest concern. Combined risks associated with 4 different exposure scenarios were considered for each chemical:

Case	Scenarios
Basic	Combines all: uses saline to model spills and aqueous cleaner to model spot cleaning; oral exposure applied only to children; direct exposure from cleaning applied only to adults
Acid Spill	Same as basic case, but with citric acid to model spills
Non-aqueous Cleaner	Same as basic case, but with non-aqueous cleaner (dry cleaning solvent)
Aged fabric	Same as basic case, but adjusting for aged / worn fabric

The staff calculated a hazard index (HI) for non-cancer hazards for each of these chemicals. A hazard index of greater than 1.0 means that the exposure may be hazardous; HI's of less than 1.0 represent minimal risks. The staff also calculated lifetime cancer risks for antimony trioxide (AT, inhalation only) and TDCP. Cancer risks exceeding 1 in a million represent actionable risks under CPSC's FHSA Chronic Hazard Guidelines.

Based on the available scientific data for the most likely FR chemical candidates, the staff drew the following conclusions:

- Four of the 8 FR chemicals evaluated--DBDPO, HBCD, CPE and PA--would clearly not be considered hazardous to consumers as defined under the FHSA. DBDPO, HBCD and CPE had HI's well below 1.0. PA did not meet the FHSA definition of "toxic," based on the available (limited) data; thus, no HI was calculated for PA. Exposure to these four chemicals by all routes would be low, even accounting for the effect of accelerated aging, which roughly doubled the amount released.

- EHDP is unlikely to be hazardous to consumers; it could present a hazard of systemic (non-cancer) effects from dermal exposure only if the treated fabric were cleaned with a solvent-based dry cleaning fluid. However, data for a surrogate (HBCD) was used to estimate exposure; therefore,

migration data specific to EHDP would be needed to confirm this conclusion.

- AT would not present a hazard from dermal or oral exposure; the HI's for these exposure routes were both low. For inhalation, estimated exposure to airborne particles containing AT is near the level of concern for cancer and non-cancer effects. However, exposure was estimated by mathematical modeling; a complete assessment of this risk would require specialized studies to gather empirical data.

- The staff could not estimate the potential risk from exposure to THPC. A significant amount of organophosphorous compounds migrated from THPC-treated fabrics, but the compounds could not be identified. Information on the identity and toxicity of the actual compounds released would be needed to determine the risk.

- TDCP appears to be hazardous for both cancer and non-cancer effects. Dermal, oral and inhalation exposures all contribute to the risk. However, data for a surrogate (HBCD) was used to estimate exposure; therefore, migration data are needed to confirm this conclusion (TDCP is currently only used in foam filling materials, and is the least likely fabric treatment candidate in this group).

Thus, a number of existing FR chemicals could be used in upholstered furniture cover fabric or barrier treatments with minimal health risks to consumers. The staff generally agrees with the findings of the NAS study on this issue. Additional exposure data are needed for antimony trioxide (AT) and tetrakis (THPC) before the chronic risks associated with these two chemicals can be estimated. The NAS report listed THPC among the "minimal risk" FR chemicals, based on an assumption that only a small amount of THPC would be released from fabrics.

Because incomplete exposure and toxicity data exist for two of the prominent candidate furniture fabric FRs (AT and THPC), the staff contacted representatives of manufacturers of these compounds, seeking additional information. The Antimony Oxide Industry Association (AOIA) is among the sponsors of an ongoing study of FR chemical risks by an independent U.K. laboratory. The first phase of this study will assess potential airborne and other exposures to AT; this phase is expected to be completed in 2002. Although industry representatives have stated that expected consumer exposures by the inhalation route are probably low, the U.K. study should yield additional laboratory or field data needed for an adequate assessment.

The staff also contacted the major world producer of THPC, to seek information on the identity and toxicity of previously unidentified extracts from THPC-treated upholstery fabric samples. The company provided some relevant data and reported that the extracts are composed almost entirely of phosphine oxide (THPO, a product of THPC; the manufacturer has stated that THPO has low chronic toxicity, although data are limited to genotoxicity and aquatic toxicity studies). The remainder of the extracts is reportedly THPC surface polymer; little is known about its toxicity, but it is not likely to be readily absorbed in its polymerized state. Additional information on THPO toxicity is needed to determine whether the amount present in upholstery fabrics may present a hazard.

The staff's risk assessment focused on the use of FR treatments for cover fabrics. Some of these FRs, principally DBDPO/AT, PA and THPC, are also candidates for use in certain cotton or synthetic barrier materials. Since barriers are beneath the wear layer of cover fabrics in upholstered furniture, potential exposure to any FR barrier finishes would be at most similar to that from cover fabrics (e.g., as a result of wear, damage or migration due to liquid extraction). It is likely that potential exposure would be much lower. Assuming similar treatment methods, FR-treated barriers would not pose any greater risk to consumers than FR-treated fabrics, and that any such risk would probably be lower for FR barriers. A number of synthetic barrier materials do not contain FR treatments; no such risk would be associated with these products.

G. Economic Analysis

The staff prepared a preliminary economic analysis of the potential economic effects of a standard and significant alternatives. This analysis described the affected products and industry groups, and estimated potential benefits and costs. The analysis also considered potential effects on small businesses. The Directorate for Economic Analysis' reports appear at Tab I.

1. Upholstered Furniture and Fabric Markets

More than 1,500 U.S. companies (with 1,706 establishments) manufacture upholstered household furniture as their primary product. Although there is a large number of upholstered furniture manufacturers, the top four companies accounted for nearly 32% of the total value of shipments in 1997; the 50 largest companies accounted for about 70%. This concentration has generally been increasing in recent years.

The value of shipments of upholstered household furniture by U.S. firms in 1997 was $8.4 billion; with net imports of about

$550 million, total consumption was about $8.9 billion. About 30 million items of upholstered residential living room and family room furniture are purchased annually in the U.S. Annual retail sales total about $20 billion.

The average product life of most upholstered furniture is about 15-17 years. The staff estimates that over 400 million pieces of furniture are in use in the U.S.

There are between 100 and 200 manufacturers of fabric for household upholstered furniture. This number includes textile mills that produce finished upholstery fabric, and textile finishers that purchase unfinished goods and perform additional operations, such as printing and dyeing. The top 16 firms account for about 80 percent of the upholstery market; as with upholstered furniture, industry concentration has reportedly increased in recent years.

U.S. upholstery fabric production in 1997 was 665.5 million square yards, about 345-360 million square yards of which went into the production of residential upholstered furniture. Approximately 2 percent of total consumption of upholstery fabric for residential furniture production is imported. About 53% of upholstered furniture cover materials are predominantly synthetic--mostly thermoplastic fabrics such as polyester, polyolefin and nylon; about 27% are predominantly cellulosic fabrics like cotton and rayon; and about 20% are leather.

2. Analysis of Potential Benefits and Costs

The potential benefits of a standard are the expected reductions in addressable fire losses from ignitions of upholstered furniture by small open flames (matches, lighters, or candles) and cigarettes. The costs of meeting the performance requirements would chiefly be reflected in higher retail prices for complying furniture.

a. Potential Benefits

To estimate the expected benefits of the draft standard, the staff first calculated the average per-unit, societal cost of fire losses. The staff then estimated the effectiveness of the standard, based on CPSC laboratory testing of products with conventional and FR-treated fabrics.* The effectiveness of the

* The draft standard allows manufacturers to use cover fabrics that may not comply with the seating area test over materials that meet an alternate barrier test. While barriers do not prevent fabric ignition, they would limit fire growth, including fires ignited by larger open flames and cigarettes. The overall effectiveness of barriers at reducing furniture fire losses is assumed to be roughly equivalent to that of FR cover fabrics.

standard was assumed to be equal to the reduction in the rate of ignition for complying fabrics. The estimates of effectiveness were applied to market-weighted sales projections to estimate the range of potential benefits.

Based on estimated 1995-1998 fire losses, the draft standard would address an annual average of 55 deaths, 375 nonfatal injuries, and about $33 million in property losses from small open flame-ignited upholstered furniture fires. Estimated annual societal costs associated with these losses were about $372 million. For the approximately 361 million units of upholstered furniture in use covered by fabrics that would be affected by a standard, expected hazard costs are a little over $1.00 per unit ($372 million / 361 million) of residential living room and family room furniture in use. Since upholstered furniture items last an average of about 15-17 years, the expected present value of these societal costs (at a discount rate of 3%) averages about $12.50 per unit over its useful life. This represents, on a per-unit basis, the maximum potential small open flame benefits of a standard that prevented all addressable fire losses.

Based on CPSC Laboratory tests of the ignition propensity of conventional and FR-treated fabrics, chairs with FR fabrics that meet the seating area mockup test are much less likely to ignite and continue burning than chairs covered with non-FR fabrics. The staff compared the relative performance observed in these tests to estimate the potential effectiveness of the draft standard. All tested chairs covered with untreated fabrics ignited and continued to burn; this occurred in only about 12% of flame applications on chairs covered with FR fabrics. The estimated reduction in ignitability was, therefore, about 88%. A statistical analysis of the laboratory test data estimated a lower bound of the expected reduction at about 76%. Since the societal costs amounted to about $12.50 per unit, the best estimate of the expected small open flame benefits of the standard would be about $11.01 ($12.51 X 88%) over the useful life of each unit of furniture produced, with a lower bound of $9.51 ($12.51 X 76%).

In addition to the small open flame benefits, CPSC Laboratory test results indicate the draft standard would also address cigarette-ignited fires. Cigarette ignited furniture fires accounted for about 443 deaths, 805 nonfatal injuries, and about $90.5 million in property damage annually; the estimated annual societal costs of these losses were about $2.4 billion.

For each unit of furniture that would be subject to the standard, average annual cigarette-related societal costs were about $6 per furniture item--roughly 6 times the per-unit small open flame hazard costs. The discounted present value of these hazard costs over the useful life of the furniture, after an

adjustment to take into account recent downward trends in cigarette related fires that are expected to continue in the absence of CPSC action, amounts to about $62.74 per furniture unit.

The staff compared the cigarette ignition propensity of chairs with non-FR fabrics (from prior testing done to evaluate the UFAC voluntary program) to that of chairs with FR fabrics that would meet the draft small open flame seating area mockup test. The proportion of cigarette tests that resulted in ignitions declined from a weighted average of 10.1% for chairs with non-FR fabrics to 2.3% for chairs with complying FR fabrics, an improvement of about 77%. The staff's statistical analysis of the test data estimated the lower bound of the expected reduction at about 50%. The societal costs of cigarette-ignited furniture fires amounted to about $62.75 per unit; thus, the best estimate of the expected cigarette benefits of the standard would be about $48.31 ($62.74 X 77%) over the useful life of each unit of furniture produced, with a lower bound of $31.37 ($62.74 X 50%).

The total expected present value of benefits of the standard, per unit of upholstered furniture produced, is the sum of reduced societal losses from small open-flame and cigarette ignitions. The best estimate of the combined benefits is about $59.32 ($11.01 + $48.31) per unit, with a lower bound of $40.88 ($9.51 + $31.37).

b. Potential Costs

The most likely means of meeting the draft standard's seating area test would be to use FR chemicals in upholstery fabrics. Most upholstery fabrics used in the manufacture of furniture in the U.S. are backcoated routinely for other purposes. Other finishing operations (such as soil and stain repellant treatments) are also routinely applied to most fabrics.

Based on U.S. industry estimates and U.K. manufacturers' experience with FR treatments, the average incremental cost to furniture manufacturers for FR-backcoated fabrics (including the cost of fabric testing) is about $0.62-$1.05 per linear yard of fabric. The estimated cost of FR immersion treatments is also in this range. The average piece of living room or family room furniture requires about 10.2 linear yards of fabric (i.e., the average quantity for chairs and sofas). Thus, total FR treatment-related costs to fabric producers would range from about $6.30 ($0.62 X 10.2 yards) to $10.70 ($1.05 X 10.2 yards) per unit.

Costs to fabric and furniture manufacturers are subject to customary price mark-ups within the chain of distribution. The retail price impact on consumers would be about 2.5 times the manufacturing cost. Thus, the standard may increase retail prices

by an average of $16-27 per piece of furniture requiring modification (comprised of an average of $11-18 for chairs and $20-34 per sofa). These increases are expected to apply to about 75% of all upholstered furniture sold, including most items covered with cellulosic- and thermoplastic-fiber fabrics.

In addition to costs related to FR treatments, fabric costs would be expected to increase as a result of testing costs to establish compliance with the draft standard. Testing costs are estimated at $.21-.28 per linear yard. These increases may result in retail price increases of about $4-5 for chairs and about $7-11 for sofas and loveseats. The estimated average testing-related retail price increase would be about $5-7 per item. Thus, total (rounded) per-unit estimated costs for items using FR fabrics would average about $22-34.

Under the draft standard, manufacturers could choose to meet an optional test that would qualify seating barrier materials; this would be an alternative to the seating area small flame test. Complying barriers could be used with fabrics that would not meet the standard's seating area test provisions. The use of barrier materials to comply with the rule would generally be more costly than FR treatments. FR treated cotton fabric barriers would cost furniture manufacturers slightly more than $2 per linear yard. Synthetic barrier materials like aramid- or melamine-fiber nonwoven fabrics may range up to $6-7 per linear yard (and would therefore probably be used much less often). Testing of barriers would add about $.01 per yard (barriers are much more homogeneous than cover fabrics, and would therefore be tested much less frequently). Manufacturers would also incur estimated labor costs of $6-10 per unit associated with incorporating barriers into furniture products.

Material and labor cost considerations likely would preclude the use of barrier materials for most furniture. Based on U.S. and U.K. industry estimates, retail price increases per item of furniture using barriers rather than FR fabrics may average about $30-43 for chairs and $50-65 for sofas and loveseats. The average increase per item made with barriers is estimated to range from about $41-55. While the use of barriers is costly, it is a viable approach to complying with the draft standard for many higher-priced products.

The cost impact of the dust cover requirements in the standard is expected to be negligible. Nonwoven thermoplastic dust covers currently used by most manufacturers would meet the standard since they generally melt away from the test flame without continuing combustion. Additionally, since nonwoven thermoplastic fabrics are less expensive than cellulosic or blended-fiber woven fabrics, the remaining manufacturers are

expected to substitute nonwoven thermoplastics for the materials they currently use.

The draft standard requires manufacturers to maintain records demonstrating compliance. This may impose minor additional labor and office space costs on firms. The staff estimated these costs to be in the range of $1,000-15,000 per firm; total estimated industry costs would be about $7.5 million, or about $0.25 per item. At the retail level, the aggregate cost to consumers would be about $19 million, or $0.63 per item.

Increases in the use of FR fabric backcoatings may increase the amount of latex-containing wastewater generated in the fabric manufacturing process; disposal of these wastes may increase costs for producers that have not previously generated such wastes. Fabric finishers already have experience in handling chemicals safely and in meeting various federal, state, and local regulations regarding environmental and worker safety. Since most upholstery fabric is already backcoated for other purposes, it is unlikely that any increase would require significant new investment in pollution-abatement equipment.

Other potential costs of the proposed standard include reductions in demand for certain types of fabrics, diversion of some stocks of upholstery fabrics to other product uses, increases in the numbers of stock-keeping units (SKU's) of fabrics by distributors, and adverse effects on aesthetic characteristics of furniture. These impacts are not readily quantifiable, but are estimated to be minor. Manufacturers concerned about potential impacts of FR treatments on fabric feel and appearance could use barriers in their products to mitigate these effects.

c. Comparison of Costs and Benefits

The combined projected benefits of reducing fires started from both small open flames and cigarette ignition sources over the useful life of furniture range from about $41-59 per unit affected. The average estimated increase in the cost to consumers of furniture that meets the standard using FR fabrics is about $22-34 per item. Thus, the projected range of net benefits to consumers is about $6 ($41 - 34, rounded) to $38 ($59 - 22, rounded) per unit of complying furniture produced with FR fabrics.

The average estimated increase in the cost to consumers of furniture that meets the standard using FR barriers is in the range of about $42-56 per item. Assuming that FR barriers would provide fire loss reductions similar to those of FR fabric treatments, the projected net benefits to consumers of the proposed standard range from about $-15 ($41 - 56, i.e., a

negative net benefit) to $18 ($59 - 42, rounded) per unit of complying furniture produced with barrier materials.

Aggregate estimates of the benefits and costs of the standard can be projected over the production cycle, based on an estimated annual production of 30 million units of upholstered living room and family room furniture. Assuming fabrics of 75 percent of the upholstered furniture would undergo FR treatment or would be used with FR barriers (i.e., excluding furniture covered with leather or vinyl), the expected *gross* benefits over the useful product life of the furniture produced in a year would range from about $920 million to $1.33 billion.

The cost of the standard to consumers would vary with manufacturers' choices regarding FR fabric vs. barrier use. Decorative fabrics, which account for about 1-2% of fabric yardage production, would probably all use barriers; a small portion of fabrics at the high end of the mass market (up to another 1-3% of total yardage for "luxury" cellulosics and blends) may also use barriers. If 95% of living room and family room furniture items undergoing changes to meet the standard were made with FR cover fabrics, and 5% were made with barriers, the range of estimated aggregate costs associated with a standard would be about $515-802 million.

Thus, *net* benefits to consumers from the standard related to living room and family room furniture would be expected to range from $118 million (projected gross benefits of $920 million - estimated costs of $802 million) to about $815 million (projected gross benefits of $1.33 billion - estimated costs of $515 million). Net benefits would be lower to the extent that more manufacturers chose to use barriers to meet the standard.

3. Analysis of Effects on Small Business

One of the staff's goals in developing the draft standard was to minimize potential impacts on small firms. About 98% of furniture producers and over 90% of fabric manufacturers and finishers would be considered "small businesses" under the Small Business Administration's definition for qualification for small business loans (fewer than 500 employees). The staff reviewed the potential impacts of a small open flame standard on small businesses, including manufacturers, suppliers, distributors and retailers. The staff also considered regulatory alternatives to mitigate effects on small firms.

Most costs associated with the standard would vary directly with the yardage of FR fabrics or barriers produced. Small firms are not expected to bear these costs disproportionately. Small furniture and fabric producers do not currently perform fabric

finishing operations, and would not be required to develop this capability to apply FR treatments.

To avoid potential adverse effects on smaller firms that specialize in higher-priced decorative fabrics for which FR treatments are most difficult, the draft standard incorporates an option allowing manufacturers to use barriers to meet the standard. This option would reduce the potential impact on decorative fabric producers and designers. The relatively greater cost associated with this option represents a relatively small increase in the total cost of such fabrics, and would not have significant impacts on the sales or profitability of these small firms.

To reduce testing costs, which tend to be more burdensome to small firms, the standard contains no requirements for firms to test all of their fabric and filling material combinations. Sampling to establish compliance would not be required for short runs of less than 50 linear yards of fabric; fabric manufacturers or finishers could test similar fabrics in a single production unit. Further, the responsibility for voluntary testing would be efficiently allocated: potential testing costs to the relatively large number of small furniture manufacturers would be minimized, because fabric and barrier suppliers (of which there are relatively few) would conduct tests and certify those components. The standard also allows substantial flexibility in methods of compliance testing: suppliers may test similar groups of seating fabrics over a standard polyurethane foam rather than testing every combination of components; manufacturers may also use complying seating barriers as an alternative to the seating area test. The draft standard's 18-month effective date also provides burden relief to small firms that may have relatively greater difficulty in designing or producing complying products.

4. Alternatives

The staff considered a number of alternatives, including modifying various features of the draft standard. These would have varying effects on potential benefits and costs. Alternatives considered include expanding or narrowing the scope of product coverage, alternative testing requirements, labeling requirements, and varying effective dates. Labeling, by itself, in lieu of a standard, could also be an option. The staff also considered a "no action" alternative, under which the Commission could rely on voluntary action to address the risk. These alternatives are discussed in more detail below.

a. Alternative Scope

The Commission could include dining chairs with contiguous upholstered seats and backs within the scope of the standard. This would affect annual production of perhaps 2-4 million dining chairs. Compliance with the standard could lead to average estimated increased consumer outlays in the range of about $5-7 per chair using FR treated fabric, with aggregate annual costs ranging from $8-24 million. Dining chairs were not identified as being the item ignited in any of the fire investigations. Thus, there is no evidence that the benefit of including these items within the standard would offset the costs.

The Commission could also include upholstered home office furniture, such as desk chairs with contiguous upholstered seats and backs, within the scope of the standard. Estimated annual sales of upholstered office furniture to the residential market are about 4-5 million units. Compliance with the standard would lead to average estimated increased consumer outlays in the range of about $3.75-5.63 per chair using FR treated fabric. An estimated 2-4 million chairs would require FR treatment, with aggregate annual increased consumer outlays totaling roughly $9-20 million annually. As with dining chairs, there is no evidence the benefits of including home office furniture within the scope of the standard would offset the costs.

The Commission could, in lieu of an alternate seating barrier test, incorporate an exemption for furniture upholstered with decorative cover fabrics, as requested by some fabric producers. The staff considered this option, in conjunction with negative labeling for non-complying products, based on the wholesale price of the fabrics (e.g., $20 per yard or above), but considered such a provision to be unwieldy. It would be quite difficult to identify the cost of fabrics on a finished article of furniture; since furniture manufacturers are ultimately responsible for complying with a standard, they would have to maintain records for each model of furniture, and affix negative labels as necessary. In addition, while residential fires occur disproportionately in low-income households, there are no fire loss data supporting an exemption based on the risk in high-income households that tend to have more decorative fabrics. Barriers may be used that would provide both consumer choice and consumer safety.

b. Testing

The Commission could adopt less stringent testing requirements for manufacturers. Sampling could be performed less frequently, or with fewer tests per sample. This could significantly reduce testing costs to fabric manufacturers and finishers, by up to several cents per linear yard. The observed variability in the

physical characteristics of fabrics and FR treatments, however, led the staff to select relatively stringent sampling parameters. The draft standard does not require sampling for short runs of fabric, thereby reducing potential costs.

c. Labeling

The standard does not contain labeling provisions. The Commission could consider a rule requiring hazard information labels 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 manufacturers. The impact of such labeling on consumer behavior and product safety, however, would be minimal. Label effectiveness is further discussed in section V in relation to the NASFM polyurethane foam labeling petition.

d. Effective Date

Flammable Fabrics Act standards generally become effective 12 months from the date of promulgation, unless the Commission finds that a different effective date is in the public interest. Many firms would probably have difficulty in developing or obtaining FR fabric treatments within the first year. Further, even though furniture producers typically change much of their fabric offerings every 6 months, many carry stocks of fabrics that are used in production runs lasting several years. A period of 18 months before the rule becomes effective would get complying products on the market in a reasonably short time, and would reduce industry disruption, especially among upholstered furniture manufacturers with large fabric inventories. Adopting an even longer (e.g., 24 month) period before the standard becomes effective would provide the affected industries with additional time to adapt their production to the new requirements and to use stocks of untreated fabrics. Fabric finishers may also develop more effective and efficient processes to achieve compliance. The beneficial effects of this alternative would have to be considered in view of the additional delay in the availability of some complying furniture to consumers.

e. No Action

The Commission could determine that no agency action is reasonably necessary to reduce the risk of fires associated with small open-flame ignitions of upholstered furniture. Under this alternative, and absent any voluntary industry action, future societal losses would be determined by ignition sources that come in contact with upholstery and the ignition resistance of upholstery materials.

Since the standard would also be expected to reduce cigarette ignitions, those losses would continue if no action were taken. Future cigarette ignition losses would be chiefly determined by the ignition resistance of materials used to manufacture furniture (mainly related to the use of predominantly cellulosic fabrics).

Factors other than furniture materials would also determine cigarette ignition fire losses in the future. Some of these would tend to increase future losses (such as projected annual increases of about 1% in population and households). Others might decrease future losses (such as continued reductions in rates of smoking prevalence and cigarette consumption, changes in the burning characteristics of cigarettes, increasing smoke alarm operability, information and education efforts, and installation of sprinkler systems in new construction). The greatest potential impact involves the ongoing development of lower ignition propensity cigarettes; however, these products are not widely being marketed, and the staff has no information with which to estimate their relative effect.

As noted in Section III.D, industry-sponsored activity currently underway may result in a future voluntary standard. Depending on its specifications and the level of voluntary conformance, such a standard could have significant benefits and costs. Since no draft voluntary standard yet exists, the potential benefits and costs are unknown; these would depend in part on the extent to which product modifications under a voluntary program were similar to those expected under the CPSC staff's draft standard. The progress of and likely conformance to a voluntary standard in the absence of further Commission action are uncertain.

5. Public Comments

Following the 1998 public hearing, the Commission received comments on economic issues relating to FR chemical use in upholstery fabrics, and comments on general economic topics such as the use of national fire loss estimates in projecting benefits of a standard, cost impacts (including impacts on small firms), and effects on aesthetics and consumer choice. The comments were generally in opposition to a standard. Affected industry representatives submitted most of the post-hearing comments received during the 1998 comment period.

During 2000 and 2001, the staff also met with representatives of furniture and fabric interests (including barrier fabric manufacturers and decorative fabric suppliers and designers) to discuss their economic concerns. Two trade associations, the American Textile Manufacturers Institute (ATMI) and the American Furniture Manufacturers Association (AFMA), sponsored reports

critiquing the economic considerations review in the staff's 1997 briefing package; ATMI and AFMA submitted these two reports in early 2001. The Decorative Fabrics Association (DFA) also submitted written comments.

The staff's economic analysis in this briefing package considered these comments and other data in evaluating the impact of the draft small open flame standard. Some of the changes the staff made to the standard were in response to the public comments. The principal issues raised in the comments are discussed below:

Issue: Use of National Fire Loss Estimates

Some industry groups criticized CPSC's fire loss estimation methodology. One commenter claimed that incidents reported through the National Fire Incident Reporting System (NFIRS) may be systematically different from those in the U.S. as a whole, and that the National Fire Protection Association (NFPA) annual survey is biased, rendering CPSC's fire loss estimates inaccurate.

The staff considers the NFIRS/NFPA-based estimates the best available. The 1999 GAO report found that NFIRS-participating fire departments were representative of U.S. fire departments; independent comparisons of NFPA survey data found them to be in agreement with data from a survey conducted by the Centers for Disease Control and Prevention (CDC). There is no evidence that the NFPA estimates are systematically biased.

Issue: Fire Trend Effects on the Potential Benefits of a Standard

A furniture industry study stated that substantial reductions in both cigarette- and open flame-related furniture fire losses would occur in the absence of any further regulation. This commenter concluded that CPSC overstated the potential benefits of a standard in its 1997 analysis.

In estimating potential benefits of a standard, the staff accounted for expected reductions in fire losses associated with projected increases in the cigarette ignition resistance of furniture in use; the staff's analysis also accounts for expected decreases in cigarette consumption and smoking prevalence. The commenter used unverifiable and questionable models to predict future cigarette fire loss reductions; under their method, cigarette fire deaths would approach zero in a few years. The staff made no adjustment for open flame losses, since the small open flame ignitability of furniture has not changed over time. The commenter incorrectly claimed that open flame fire fatalities have fallen when the staff's trend analysis showed no such decline.

Issue: Estimation of Benefits of a Standard

One commenter suggested that CPSC had not considered the long period of time over which the safety benefits of a standard would accrue, and that CPSC had assumed a standard would achieve full effectiveness in its first year; thus, projected future benefits should be divided by 14, the number of years in the average useful life of upholstered furniture. Some commenters also suggested that a higher discount rate (of up to 7-10%) should be applied to future benefits. They also questioned the staff's value-of-life and injury cost estimates.

The staff agrees that the benefits of a standard for upholstered furniture, or any durable consumer product with a long service life, would accrue gradually over time. The staff's analysis did not assume immediate full effectiveness, but rather calculated the expected benefits associated with a given year's production of complying furniture over its useful life. The commenter incorrectly reduced the projected benefits, since the fact that benefits would accrue over many years was implicit in the staff's calculations. The staff also did not assume full effectiveness within 14 years--the time it would take for most furniture in use to be small open flame resistant; the staff discounted benefits over 50 years, under the assumption that some products would still be in use that long.

A substantial body of research exists on the appropriate discount rate to use when considering future benefits of safety standards or other social policy actions. The preponderance of the literature suggests 1-3%. The staff's 1997 report used 2.5%; the current economic analysis uses 3.0%. While OMB recommends a higher rate for discounting benefits of capital projects, federal health and safety agencies generally use the lower range of rates for comparative analyses. The staff concluded that a 3% discount rate is sufficiently conservative so as not to overstate the benefits of the draft standard. Additionally, the staff performed a sensitivity analysis using alternate discount rates; this analysis shows that using different rates would have relatively little effect on estimated benefits.

Similarly, the CPSC staff's estimate of $5 million per life is well within the range of values suggested by the best available value-of-life research. There is no justification for adjusting value-of-life estimates downward for people in different age groups. The staff's $170,000 average injury cost figure is also based on extensive research, and reflects the pain and suffering components of many non-fatal fire injuries. The difference between the commenter's suggested value and the CPSC staff's

average value is roughly equal to the pain and suffering component of the fire injury estimate.

Issue: Counting Cigarette Benefits

Several commenters said it was inappropriate to consider safety benefits from reduced cigarette-ignited fires, as the draft standard does not specifically address the cigarette ignition risk. They estimated that substantial negative net benefits would accrue from a small open flame standard if cigarette benefits were not counted.

The CPSC staff considered *all* known benefits and costs associated with the draft standard. The standard was crafted to avoid increasing the cigarette ignition risk; however, CPSC laboratory testing, supported by statistical analysis of test results, suggested that cigarette ignitions would actually be *less* (not more) likely on furniture made with FR fabrics. If there were significant secondary costs associated with a standard, the staff would have considered those even if they did not directly relate to the risk being addressed or to the products subject to the standard. Potential benefits were considered in this same manner.

While it is true that projected cigarette fire loss reduction benefits account for the majority (about 80%) of total estimated benefits of the draft standard, counting only about half of these benefits would achieve equal costs and benefits. Adding cigarette ignition performance provisions could increase these benefits; however, most of the benefits would be achieved without specific requirements for cigarette ignition resistance.

Issue: Impacts on Decorative Fabrics

Firms marketing decorative fabrics--those typically used by interior designers in custom home furnishings--asserted that decorative fabric producers and converters (which are virtually all small firms) would be especially burdened by a standard requiring FR fabric treatments, due to the difficulty of obtaining adequate fabric finishing services and the adverse effect of FR treatments on aesthetic qualities of some fabrics (e.g., color, drape, and feel or "hand"). Other textile industry representatives also expressed concern that the current wide selection of upholstery cover fabrics would be curtailed under a standard.

The staff agrees that some fabrics, including many current decorative fabrics, cannot be readily treated using existing FR chemical systems without severe aesthetic effects. Some of these fabrics would likely be discontinued or diverted to other uses.

The use of barrier materials instead of FR treatments for some fabrics would reduce the loss of consumer choice that might result from FR treatment. It would also reduce the economic impact on firms that specialize in those fabrics most adversely affected by FR treatments.

Most fabrics, including some decorative fabrics, are currently backcoated. Fabric finishers have reported that the equipment already used to non-FR backcoat fabrics is also used for FR backcoating. While it is possible that treatment facilities may be heavily used in the short run, long-term capacity is expected to be adequate, and there is no reason to believe that treatment costs would escalate substantially under a standard.

Issue: FR Treatment of Non-Furniture Fabrics

Some firms commented that fabric manufacturers and distributors do not necessarily know the end uses of their fabrics. Therefore, either all fabrics used in draperies and other fabric-covered products would have to be FR-treated, thereby raising costs and prices and affecting fabric selections for products not within the scope of the draft standard; or firms would have to custom-treat fabric yardage selected specifically for furniture use, and maintain dual fabric inventories to ensure compliance. One commenter suggested that CPSC substantially underestimated the yardage of upholstery fabric that would be FR-treated in view of this uncertainty.

A small open flame standard would not significantly affect non-furniture markets for fabrics. Most firms know which of their customers would use which fabrics for furniture upholstery. While very small yardage orders sent to contract finishers are often subject to a minimum charge (increasing the total per-yard cost), this would not apply to the vast majority of fabrics that would be treated to meet the draft standard. The availability of a barrier option for furniture fabrics greatly reduces this potential effect, and reduces the need for separate fabric inventories.

The available data on fabric used in upholstered furniture indicates that of the approximately 600 million square yards of fabric that could be used in furniture, actual consumption is only about 290-340 million square yards. Applying the appropriate cost estimates to the appropriate affected fabric base yields much lower total industry costs than suggested by the commenters. Treated yardage would be slightly lower to the extent that complying barriers are used with some (generally higher-priced) fabrics.

Issue: FR Treatment Costs

Some commenters stated that CPSC underestimated FR fabric treatment costs. A textile industry study reported the results of a survey of fabric producers and finishers, citing examples of up to about $3.00 per yard at the manufacturing level for some fabric treatments. The commenters also said that many small manufacturers could not themselves apply FR treatments, but rather would be forced to use contract finishers, and that existing fabric finishers would be overtaxed, thereby driving up costs.

Flame retardant fabric finishes are not currently applied to residential furniture fabrics sold in the U.S. Based on reports from U.K and U.S. finishers that serve the U.K. market, large scale FR finishing would cost manufacturers roughly $1.00 per yard, depending on the treatment method. Most upholstery fabrics are currently (non-FR) backcoated, usually by contract finishers; FR formulations are readily incorporated into existing backcoating operations.

In the U.K., fabric producers have reduced costs by having short runs of similar fabrics sewn together and treated in larger quantities. The higher charges currently associated with custom finishing on small-yardage orders would not generally apply to FR treatments. The textile industry survey primarily covered small producers of decorative fabrics (and only one finisher); these firms are not representative of the whole upholstery fabric market. A few of the largest fabric manufacturers are already equipped with integrated finishing facilities; these firms would probably incur the lowest incremental costs. However, increasing the use of contract finishers would not financially harm smaller firms.

Issue: Costs of Environmental Controls

Some industry commenters stated that if they produced or handled FR-treated fabrics, they would incur substantial costs associated with pollution abatement equipment, especially wastewater controls. These potential costs were related chiefly to state and local environmental regulations.

The staff agrees that some larger textile producers that choose to perform their own FR fabric treatment operations may incur environmental control costs, to the extent that they may need to obtain additional water use permits, install new wastewater treatment equipment, etc. Most fabric and furniture manufacturers, however, would not generate significant additional quantities of water or other waste under a standard, and would not face increased costs. Independent finishers who are already equipped to handle applicable chemical controls would generally

perform fabric treatments; fabric finishing prices reflect the cost of state and local chemical and occupational safety regulations. Most fabric producers would have no FR chemicals in their plants. Furniture manufacturers would generate negligible additional FR-containing wastewater as a result of a standard. Fabric waste is generally recycled (i.e., sold) for use in other products; the presence of FR treatments would not significantly affect this secondary market. Overall industry costs associated with environmental controls are estimated to be low.

H. Environmental Review

The CPSC staff prepared a preliminary review of potential environmental effects associated with the draft small open flame upholstered furniture standard. This report appears at Tab J.

Over 600 million pounds of FR chemicals were consumed in the U.S. in 1998 in a variety of product applications, chiefly plastics such as wire and cable insulation, television and computer cabinets, and urethane foams. Over 160 million pounds of FRs are used annually in textile products, mainly carpeting, but also protective apparel and upholstery for transportation (e.g., airplane and automotive) seating and commercial furniture. Based on industry estimates of FR fabric application requirements, FR chemical increases associated with a standard may be up to 25-30 million pounds. This represents an increase in FR consumption for all uses of about 3-5%.

Some of the FR chemicals that firms may use to meet a standard are toxic. As noted in the risk assessment (section III.F.4, above), exposure and bioavailability are equally important factors in determining risk, both for human health and the environment. Various other chemicals used in fabric manufacturing and finishing may also be toxic. Worker safety and environmental controls exist to mitigate any potential hazards associated with these chemicals. Textile manufacturers and processors have been using FRs and other chemicals for years without reported adverse environmental impacts. NIOSH's preliminary investigation report suggests that marginal increases in worker exposures and risk would be negligible for the compounds under consideration.

Studies examining environmental fates of FR chemicals have largely focused on the most persistent and bioaccumulative bromine-based FRs, such as polybrominated and polychlorinated biphenyls (PBB's and PCB's) and certain lower-brominated diphenyl oxides. These are not candidates for use in upholstery fabrics.

The presence of FR chemicals in furniture upholstery would not significantly affect the acute toxicity of combustion products

in residential fires. While smoke produced from burning plastics, paints, foams and other materials in such fires is toxic, there would presumably be fewer residential fires, and thus fewer chemical pollutants, if FR materials were used. Moreover, the same FRs expected to be used in furniture upholstery already appear in other household products; thus, no incremental increase in toxic smoke production would be expected. Polyvinyl chloride and other plastics found in homes also produce dioxins and furans. Any increase in the production of these compounds from FR fabrics would be small.

Disposal of FR-containing furniture would not harm the environment. Disposal in landfills would not significantly affect water quality, since most of the likely FRs are not volatile or water-soluble. These compounds would break down slowly, and would not migrate readily from disposal sites to ground or surface waters. Airborne pollution from incineration would also be minimally affected by the small projected increase in FR usage associated with a standard, even if all upholstered furniture fabrics (including barrier fabrics) were FR-treated.

Based on available scientific data, a standard is unlikely to have significant impacts on air or water quality or other aspects of the environment. As noted in section III.F.3, above, the CPSC staff is working with EPA to develop a Significant New Use Rule; this would allow EPA to examine and, if necessary, limit the use of any FRs that may present environmental risks or for which insufficient data exist to evaluate such risks. This action would help ensure that no hazardous FRs would be used to meet a CPSC flammability standard.

IV. Cigarette Ignition Evaluation

The 1997 briefing package presented an evaluation of the cigarette ignition resistance of upholstered furniture available to consumers, and of the level of industry conformance to the Upholstered Furniture Action Council (UFAC) voluntary guidelines. The staff believes the conclusions of that evaluation are still applicable.

A. Ignitability of Current Furniture

Based on data from a CPSC survey completed in 1996, an estimated 83% of currently manufactured upholstered furniture resists smoldering cigarette ignition, based on sales-weighted estimates of CPSC laboratory test results. In its testing over the years, the staff has observed a steadily increasing proportion of cigarette-resistant furniture on the market: the most recent estimate represents about a 70% improvement over the past two decades. This reflects increased usage of cigarette-resistant synthetic fabrics and filling materials.

Along with the general increase in cigarette resistance over time, fire losses have declined by a similar percentage. Safer furniture has undoubtedly contributed significantly to this decline, as well as a combination of factors, including reduced smoking, increased smoke alarm usage, and medical and fire service advances. As noted in Section II, however, cigarette ignited furniture fires still accounted for hundreds of deaths and injuries in 1998.

Further improvements in cigarette ignition resistance are possible for the roughly 17% of currently marketed furniture still prone to smoldering ignition. Most of these tend to have heavier-weight cellulosic fabrics whose propensity to smolder cannot be overcome by synthetic filling materials. CPSC laboratory tests suggest that FR treatments or barriers used to comply with the draft small open flame standard would also address the continuing cigarette ignition risk associated with these units.

B. UFAC Conformance

Based on the 1996 survey, an estimated 86% of currently manufactured upholstered furniture, including products from non-UFAC member firms, meets the UFAC cigarette ignition component guidelines. This also represents a considerable improvement over the estimated under-50% conformance level of the late 1970's, when the UFAC program was first established. The UFAC program has undoubtedly contributed to the higher level of safety in upholstered furniture produced in recent years.