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

MEMORANDUM

DATE: December 10, 2005

TO : Mike Babich, Ph.D., Directorate for Health Sciences (HS)

THROUGH: Andrew G. Stadnik, P.E., Associate Executive Director
Directorate for Laboratory Sciences (LS)
Joel R. Recht, Ph.D., Director, Division of Chemistry (LSC)

FROM : David Cobb, Chemist, Division of Chemistry DC
Bharat Bhooshan, Ph.D., Division of Chemistry B.B.

SUBJECT : Migration of Flame Retardant Chemicals in Upholstered Furniture Foam

SUMMARY:

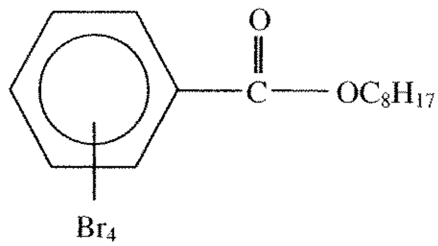
Two commercially available foams that may be used to make upholstered furniture compliant with the proposed flammability standard were analyzed for flame retardant chemical (FRC) content and subjected to several migration scenarios to simulate potential consumer exposure to FRC during use of product.

1. A foam treated with tris (2,3 –dichloropropyl) phosphate (TDCP) was analyzed for total TDCP content. This foam was designated "S" by Division of Engineering, Laboratory Sciences (LSE) and has been used in flammability testing. The total TDCP content averaged 6.6% (manufacturer's claim 7.8% based on chemical feed rate not chemical analysis). Foam slabs measuring 9"x9"x3" were covered with cotton fabric and attached to 9"x9"x1/2" plywood. These miniseats were subjected to liquid mediated surface migration to simulate dermal contact, and subjected to pounding for 100,000 cycles while sampling air for FRC particles. Aliquots of the foam were heated to 100°C and sampled for FRCs released in the gas phase.

2. Another foam was treated with FM-550®. This foam was designated Z" by LS. The material safety data sheet (MSDS) for FM-550® indicates it contains a mixture of halogenated aryl esters and aromatic phosphates, such as triphenyl phosphate. GC-MS chromatographs showed three major components. The mass spectra indicated they are triphenyl phosphate (4.7 minute retention time), tri(propylphenyl) phosphate (also called isopropylated teiaryl phosphate) (5.3 minute retention time) and octyl tetrabromo benzoate (7.4 minute retention time), with the structure given below:

491

Figure 1:Structure and Formula for Brominated Component of FM-550®



The total FM-550® content was 6.8%. The foam was subjected to the same migration tests as the TDCP foam.

BACKGROUND:

LSC was requested to determine chemical load and exposure potential of two FRCs that are found in upholstered furniture foam. Two commercially available foam materials were tested. The FRCs used to treat the foams includes melamine, TDCP, and FM-550®. Due to its low toxicity, melamine was not evaluated

This study can be broken down into 4 phases. Phase 1 involved determining the total FRC load in the foam materials. Phase 2 involved migration tests to determine potential dermal exposure. Phase 3 involved durability and airborne sampling of mattress mockups with FRC containing barriers under conditions simulating use. Phase 4 involved measuring the FRCs in the gas phase produced by heating the foam samples.

PHASE 1 BARRIER SAMPLE ID AND FRC LOAD

Information on the two foam samples along with the average chemical load found by LSC is contained in Table 1. The FRC percentages listed in Table 1 are the average from 2 replicates.

Table 1. Foam Identification

CPSC Staff Designation	Color	FM-550® % (w/w)		TDCP % (w/w)	
		Manufacturer Claim	CPSC Analysis	Manufacturer Claim	CPSC Analysis
S	Dark Gray	NA	NA	7.8	6.6
Z”	Light Green		6.8	NA	NA
Y	Yellow	NA	NA	3.0	3.5

Total TDCP chemical load of S and Y foams were determined by extracting 30-70 mg aliquots of the foam sample in 10 ml of acetonitrile. The sample vials were covered, shaken by hand for approximately 1 minute, and then allowed to sit at room temperature for at least 24 hours to extract the TDCP FR chemical. The extract was spiked with an internal standard of decanoic acid and analyzed using gas chromatography mass spectrometry (GC-MS) to determine TDCP content. The retention time for decanoic acid was1.7 minutes, and the retention time for TDCP was 5.0 minutes. A linear regression was developed on a set of reference samples containing TDCP and decanoic acid as an internal standard in acetonitrile solution. Peak area ratios were used to determine the concentration of TDCP in solution. The conditions that were used for the GC analysis were as follows:

Column-DB-5MS, 0.25 mm ID, 30 m, 0.25 um
Oven Temperature – 210 °C (1 min)/50 °C/min/260°C
Injector temperature 280 °C
Carrier gas – Helium, 1.0 ml/min
Injection – 1ul liquid, 50:1 split injection

The FM-550® content of foam Z" was quantitatively determined by extracting 30-70 mg foam aliquots with acetonitrile. The extracts were analyzed using both GC-MS and HPLC. Decanoic acid was used as internal standard for the GC-MS analysis. Calibration curves were developed based on peak ratios for each of the 3 peaks detected by GC-MS analysis and the peak areas for the 2 peaks detected by HPLC analysis. The 2 peaks that were detected by HPLC analysis of FM-550® occurred at 3.9 minutes and 7.3 minutes. Neither of these peaks is attributable to triphenyl phosphate. The FM-550® results listed in Tables 1, 2, and 3 are based on the 1st peak detected during HPLC analysis, which was the tallest peak. This peak is due to the brominated ester not the phosphate compounds.

PHASE 2 MIGRATION TESTS

Surface migration tests were done on miniature furniture mockups that consisted of 9"x 9" x 1/2" plywood covered with 9" x 9" x 3" slab of the FRC treated foam, covered with standard velvet cotton fabric. The mockups were wetted with 25 ml of saline (0.9% sodium chloride solution), a dry circular Whatman® #2 filter paper having a diameter of 5.5 cm filter paper was placed on top, and the 1 psi weight was placed on the filter paper for 6 hours. The weight was removed and the dry filter papers were placed in test tube for applicable FRC analysis. The miniature furniture mockups were wetted the following day with 25 ml of saline, a dry filter paper placed on top, and the 1 psi weight placed on the filter paper. The process was repeated until a total of four consecutive extractions were done for each miniature furniture mockup. The results of the mockup migration test are contained in table 2. The mockup containing the S foam was subjected to 4 additional days of saline exposure due to increasing TDCP levels detected for the 1st set of 4 day exposure results. The TDCP amounts seemed to level off and remain fairly constant for the 2nd set of 4 days. A mockup with the Y foam and a 2nd mockup with the Z" foam were subjected to an 8 day exposure test.

Table 2. Surface Migration to Filter Paper

Foam	Filter Paper Extract	FRC	µg FRC
S	1	TDCP	1.4
	2		3.8
	3		8
	4		7.2
	5		4.9
	6		4.8
	7		5.1
	8		4.2
	Total		**39.4**
Z" 1	1	FM-550®	<0.4
	2		<0.4
	3		0.4
	4		1
	Total		**1.4**
Y	1	TDCP	1.5
	2		2.5
	3		2.2
	4		2.8
	5		2.5
	6		2.8
	7		2.2
	8		2.2
	Total		**18.7**
Z" 2	1	FM-550®	<0.4
	2		0.4
	3		0.4
	4		1.2
	5		2.5
	6		2.8
	7		1.8
	8		1.8
	Total		**10.9**

PHASE 3 DURABILITY – AIRBORNE TESTS

Miniature furniture mockups as described previously were subjected to continuous impaction while sampling the air above the mockups for FRC. Photographs of the barrier mockup impactor test setup along with a miniature furniture mockup are contained in figures 1a and 1b. The impactor was constructed by Directorate of Laboratory Sciences, Division Mechanical Engineering staff and consisted of an air piston driven plastic concave head with a diameter of 4". This type of test was done for mattress barriers and reported.[1] The impactor conditions used were as follows:

1. 100,000 cycles
2. 1 second per cycle, 0.5 seconds in each direction
3. 3 psi impact force, stroke length set so that impactor head did not bottom out during cycle

The mockup impactor tests were done inside an inflatable glove bag placed over a frame. The frame had dimensions of 13.5" x 20" x 27". The bag was sealed during impaction testing. The air sampling was done using calibrated sampling pumps to draw a known volume of air through membrane filter contained in a styrene cassette. The sampling was done using button aerosol samplers. This sampling technique collects inhalable particles smaller than 100 µm. There were 2 sampling sites within the frame. The air sampling conditions were as follows:

1. 4 liters per minute
2. 25 mm diameter 0.8µm mixed cellulose filter

Filters collected from the air sampling were digested in acetonitrile. The digested filters were analyzed for TDCP and FM-550® using GC-MS. All of the analysis results for FM-550® were below the method detection limit (MDL). Most of the analysis results for TDCP are below the MDL. The MDL for FM-550 is 0.4µg and TDCP is 0.24µg. Circular Whatman® #2 filter papers with 5.5 cm diameter were placed inside the bottom of the impaction test frame near the mockups during testing. The filter papers were placed close to the mockups to collect particles ejected from the mockups during impaction that would be too large or too small to be collected on the filter cassettes using the aluminum cyclones. The filter papers were extracted in acetonitrile using Soxhlet extractors and analyzed using GC-MS. The results are contained in table 3.

[1] CPSC Memo "Migration of Flame Retardant Chemicals in Mattress Barriers", Cobb, David, dated December 2005

Table 3. Airborne Sample Results

Foam ID	Mockup ID	Filter ID and (Type)	Time (hrs)	Air Volume (l)	TDCP µg	FM-550® µg
S	1	1 (MCE)	28	6720	<0.25	
		2 (MCE)	28	6720	<0.25	
		1 (Whatman®)	28	6720	<0.25	
S	2	1 (MCE)	28	6720	<0.25	
		2 (MCE)	28	6720	5.8	
		1 (Whatman®)	28	6720	<0.25	
Z"	1	1 (MCE)	28	6720		<0.4
		2 (MCE)	28	6720		<0.4
		1 (Whatman®)	28	6720		<0.4
Z"	2	1 (MCE)	28	6720		<0.4
		2 (MCE)	28	6720		<0.4

Figure 1a

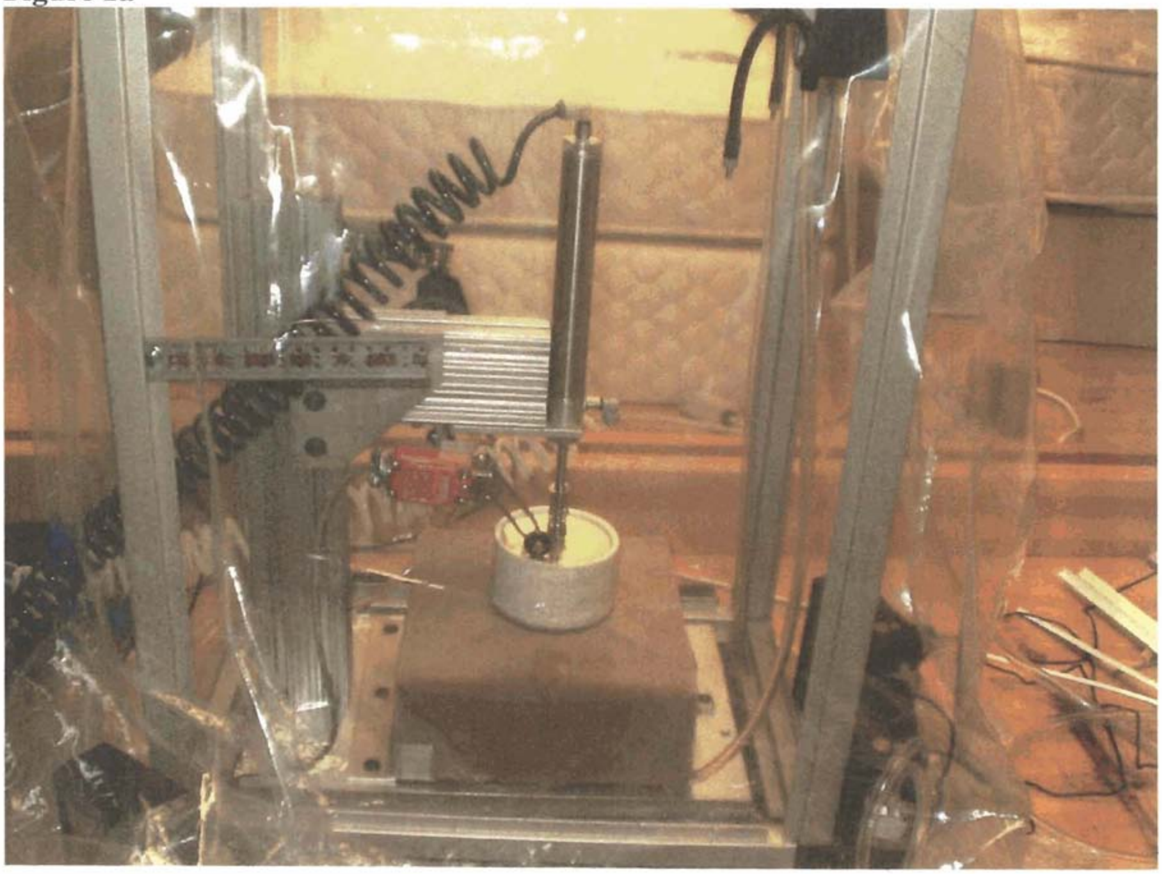
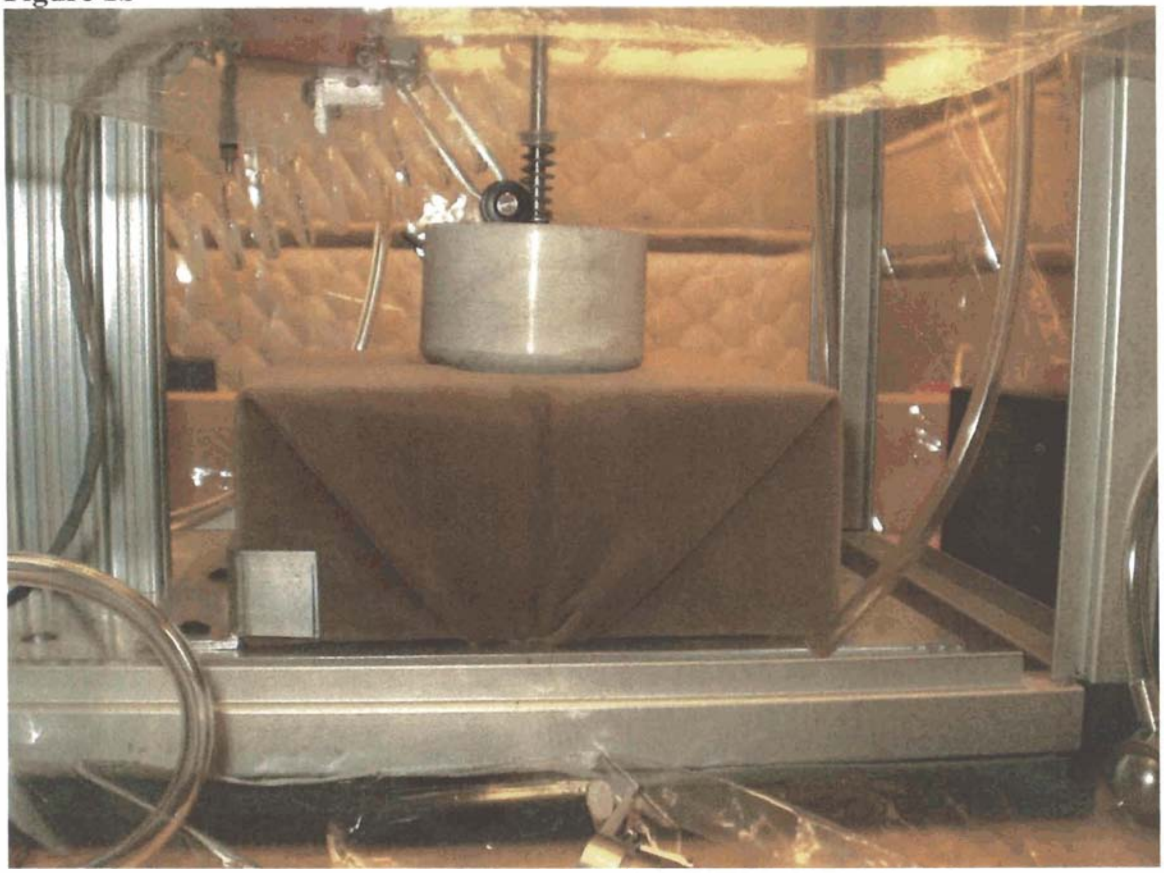


Figure 1b



PHASE 4. OFF GASSING FROM TDCP AND FM-550

The off gassing of the FRCs was determined by adding about 200 mg of TDCP or FM-550 to a two-liter round-bottom flask. The flasks were closed with Teflon closures that allowed removal of headspace (100 µl) with a gas-tight syringe (250 µl). The flasks were placed in an oven maintained at 120°C. After 15 minutes, 100 µl of headspace was removed from a flask and injected into the GC/MS for analysis. A total of six injections (three from each flask) were made into the GC/MS. Peak for either TDCP or FM-550 was observed after each injection. The GC conditions were as given below:

Column	J&W DB-1, 0.25 mm ID, 30 m, 0.1µm OD
Oven Temperature	250°C (3)/@ 40°C/280°C (5)
Injection Temperature	280°C
Carrier gas	Helium, 1.0 ml/min
Injection	100.0 µl, split 1:50

The temperature of the oven was decreased to 65°C and after waiting for 15 minutes, two injections (one from each flask) were made into the GC/MS. No peaks were observed.

Standard solutions containing TDCP and FM-550 at 50, 100, and 200 ppm (230g/ml) were prepared using acetonitrile as solvent and analyzed (2.0 µl injection) at the same time. All standard solutions contained a cyclic olgomeric phosphonate as an internal standard (50 µg/ml). Since internal standard was not added to the flasks, the concentrations of TDCP and FM-550 can only be assessed from the peak areas obtained. Results from experiment A are given in Tables 4 and 5. Injection of TDCP into the GC/MS showed only one peak at 3.88 minutes but FM-550 gave three peaks with retention times 4.23, 4.93 and 6.78 minutes along with numerous small peaks at 5.45 to 6.3 minutes. Measurement of peak area for the peak at 4.23 minutes was used to quantitate FM-550. Thus, the peak areas for TDCP in general are about four times, when compared, for the same amount of FM-550. The internal standard gave two peaks at 2.46 and 2.56 minutes; however, the peak area for the large peak at 2.46 minutes was used to quantitate the internal standard.

Table 4

Concentration (µg/ml)	TDCP/I.S ratio	FM-550/I.S. ratio	Average peak area		
			Internal Std (I.S.)	TDCP	FM-550
50	1.167	0.292	8320839	9706685	2431270
100	2.543	0.653	11395096	28977909	7441068
200	5.451	1.444	12834011	69953239	18530863

Table 5

F R Chemical	Flask Temperature	Peak area	Average Peak area	Approximate concentration (ppm)
TDCP	120°C	7564434	6569889	30 to 35
		6445294		
		5699938		
FM-550	120°C	7646019	5298032	75 to 80
		3566385		
		4681692		
TDCP	65°C	1445444		5 to 8
FM-550	65°C	none		none

Data in Tables 4 and 5 suggest that the concentration of TDCP during off gassing from TDCP (Chemical) at 120°C is approximately 30 to 35 ppm and decreases to about 5 to 8 ppm at 65°C. For FM-550, the corresponding concentration is about 75 to 80 ppm at 120°C but decreases to below detectable levels at 65°C.

PHASE 5 OFF GASSING FROM FOAMS CONTAINING TDCP AND FM-550

The experiments were performed exactly as discussed above except that each flask contained about 3.5 grams of foam containing either TDCP or FM-550. Figure 2 shows GC scan obtained from the off gassing of TDCP containing foam at 120°C. Figure 3 is the mass spectrum (upper) for the corresponding peak at 3.86 minutes; the lower spectrum is the matching spectrum from the library. Similarly, Figure 4 shows GC scan obtained from the off gassing of FM-550 containing foam at 120°C. Figure 5 is the mass spectrum (upper) for the corresponding peak at 4.23 minutes; the lower spectrum is the matching spectrum from the library.

Data in Tables 6 & 7 suggest that the concentration of TDCP during off gassing (from foam containing TDCP) at 120°C is approximately 10 to 12 ppm and decreases to below detectable levels at 65°C. For FM-550, the corresponding concentration is 15 to 20 ppm at 120°C but decreases to below detectable levels at 65°C. From these experiments, it may be concluded that at room temperature, the headspace concentrations of TDCP and FM-550 in foams containing these chemicals will be well below the detection limit of these chemicals. The limit of detection is about 5 ppm and the limit of quantitation is about 15 ppm.

Table 6

Concentration (μg/ml)	TDCP/I.S ratio	FM-550/I.S. ratio	Average peak area		
			Internal Std (I.S.)	TDCP	FM-550
50	1.203	0.297	6362954	7655511	1892241
100	2.950	0.745	6065414	17890579	4519769
200	6.275	1.631	7147311	44848963	11655755

Table 7

F R Chemical	Flask Temperature	Peak area	Average Peak area	Approximate concentration (ppm)
TDCP	120°C	2241744	1269665	10 to 12
		974968		
		592282		
FM-550	120°C	828649	880782	15 to 20
		725661		
		1088035		
TDCP	65°C	none		none
FM-550	65°C	none		none

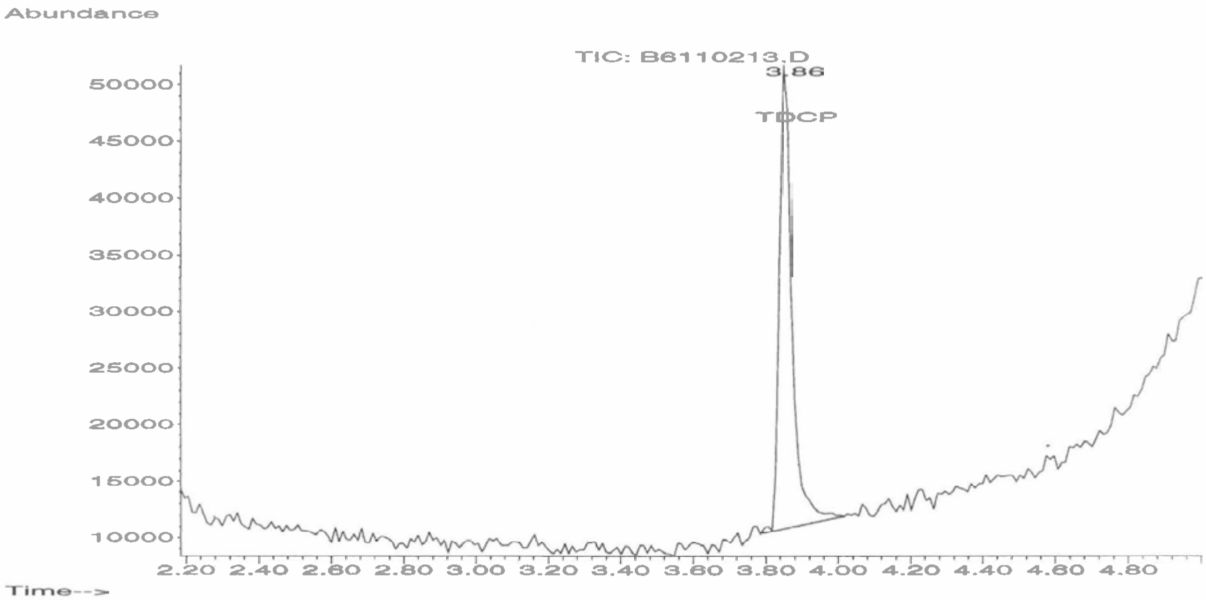


Figure 2

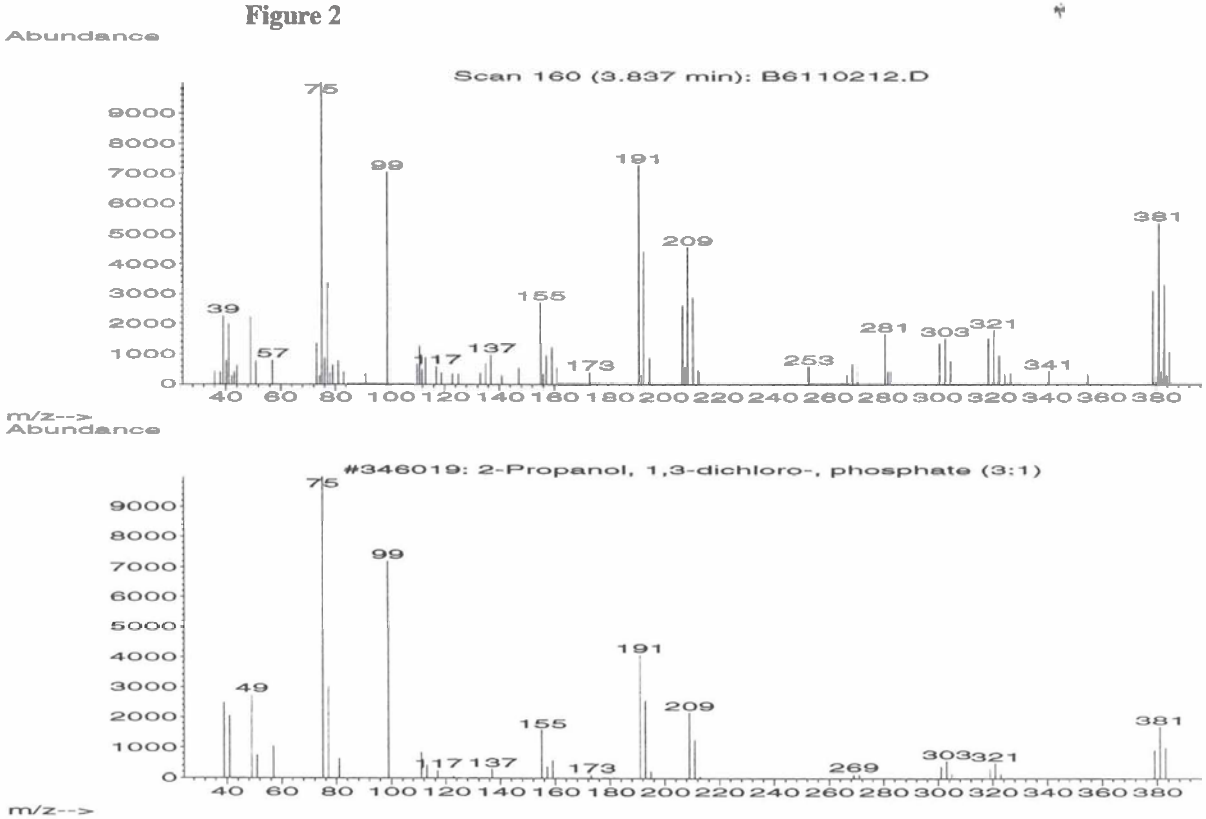


Figure 3

500

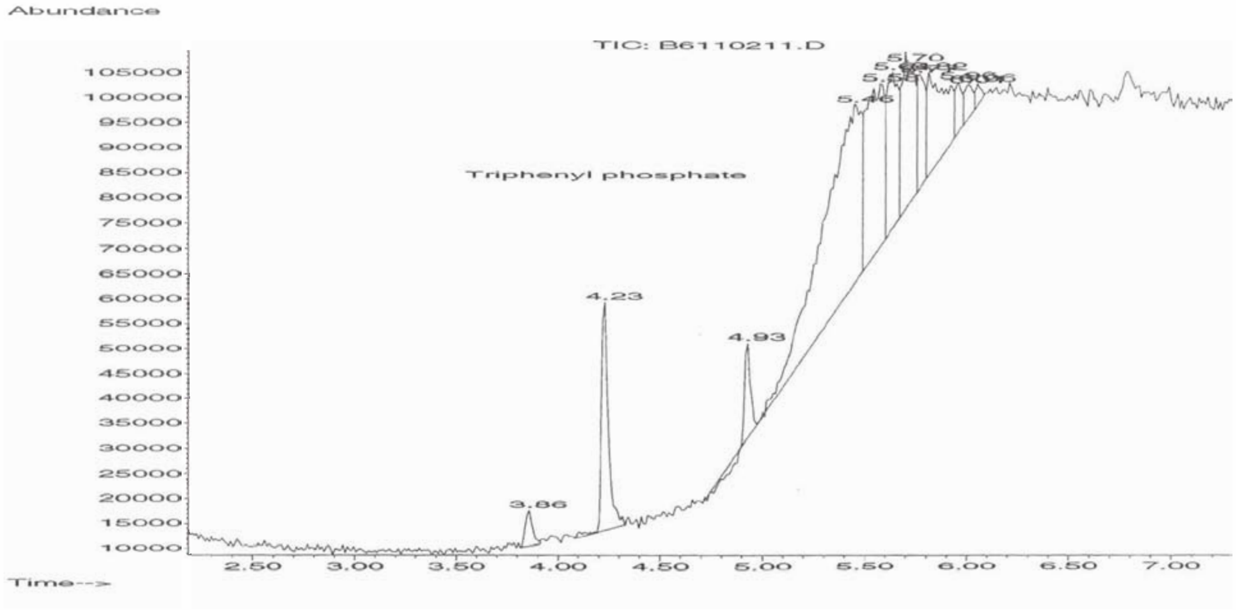


Figure 4

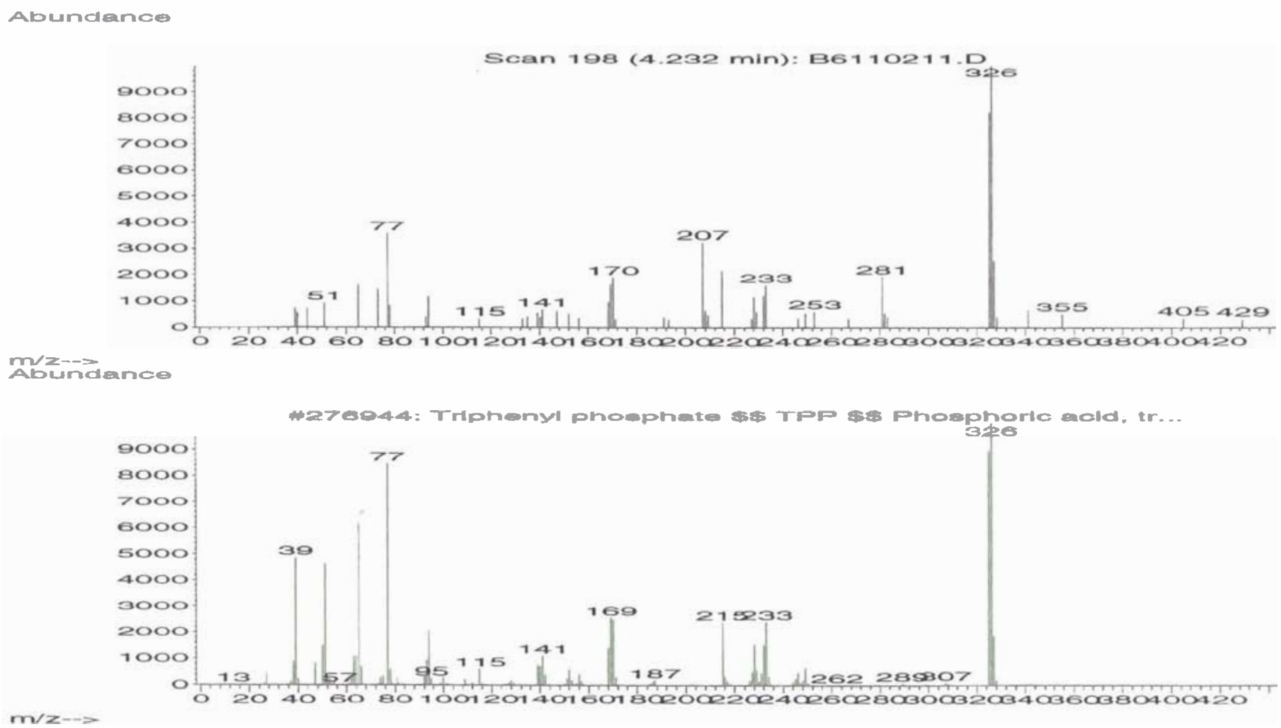


Figure 5

Preliminary Environmental Assessment of a Draft Flammability Standard for Residential Upholstered Furniture

Robert Franklin
Directorate for Economic Analysis
30 January 2006

Preliminary Environmental Assessment of a Draft Flammability Standard for Residential Upholstered Furniture

Introduction

This report discusses the potential environmental impact of the 2005 revision to the draft flammability standard for upholstered furniture developed by the staff of the U.S. Consumer Product Safety Commission (CPSC). The draft standard is intended to reduce deaths, injuries, and property damage from fires originating in residential upholstered furniture (RUF). Generally, CPSC rules establishing performance requirements are considered to "have little or no potential impact for affecting the human environment" and environmental assessments are not usually prepared for these rules (see 16 CFR § 1021.5 (c)(1)). However, in order to meet the requirements of the draft standard, manufacturers will have to change some of the materials that they use in RUF. For example, many filling materials and some cover fabrics may have to be treated with flame-resistant (FR) chemicals or a flame resistant barrier may have to be added to the furniture. Therefore, a more thorough consideration of the potential environmental impacts is warranted.

This analysis concludes that since the draft standard is a performance standard, manufacturers will have several options for meeting the requirements. Although there are still some unsettled questions, there appear to be several promising methods that manufacturers could use without posing an unacceptable health risk to consumers or significantly affecting the environment. Moreover, even if a chemical used by some furniture or component manufacturers is later shown to pose an unacceptable risk to human health or the environment, there are various regulatory and other mechanisms that could be used to remove the chemical from applications where it poses a risk.

Purpose

The purpose of the draft standard is to reduce deaths and injuries due to fires that originate in upholstered furniture. Fires starting originating in upholstered furniture are responsible for an estimated 460 deaths and 1,100 injuries annually. These are often caused by lit cigarettes falling onto the furniture and smoldering until a fire starts or by small open flames, such as a candle toppling over or from children playing with matches or lighters. The standard is expected to reduce the societal costs associated with these fires by at least 50 percent.[1]

[1] Charles L. Smith, "Preliminary Regulatory Assessment of a Draft Proposed Rule to Address Cigarette and Small Open Flame Ignitions of Upholstered Furniture," U.S. Consumer Product Safety Commission, Bethesda, MD (October 2005). Hereafter cited "Smith (2005)."

Requirements of the Draft Standard

The draft standard provides manufacturers with two options for meeting the requirements. One option is to use filling materials and cover fabrics that pass the tests prescribed in the draft standard. Filling materials, such as polyurethane foam, cotton batting, polyester fiberfill, down feathers, and polystyrene beads, must pass a smoldering ignition resistance test and an open flame ignition resistance test. Cover fabrics must pass a smoldering ignition resistance test. The other option is to use a flame-resistant barrier or interliner that has passed the appropriate tests described in the draft standard in lieu of using complying cover fabrics or filling materials. The cover fabric may serve as an FR barrier if it passes the cover barrier ignition resistance tests described in the draft standard.

The draft standard does not prescribe any specific treatment or method that manufacturers must use to meet the standard. However, CPSC staff believes that many filling materials (e.g., resilient foam) and some cover fabrics will require some modification in order to comply with the standard. The modifications might involve incorporating FR chemicals into the component, replacing more ignition prone materials with materials that are less ignition prone, or using a complying FR barrier or interliner.

Potential for Affecting the Environment

If the draft standard has any adverse environmental impact it will likely result from the use of FR chemicals to meet the requirements. FR chemicals are not a specific class of chemicals, but include many different types of chemicals. Chemicals that can have flame retardant properties include some chemicals that are boron, phosphorous, nitrogen, bromine, and chlorine-based. Antimony trioxide is often used with some other FR chemicals as a synergist.

Life Cycle of Residential Upholstered Furniture

In considering the environmental impact of a standard, one must consider the impact at each stage of the life cycle of the product. In the case of FR chemicals and barriers used in RUF, this will involve the extraction and refinement of raw materials and the use of these materials to manufacture the FR chemicals or materials. These materials must then be incorporated into the furniture components, such as the filling materials, cover fabrics, and barriers. These processes involve the use of labor, energy, and other chemicals. During these processes workers may be exposed to some of the chemicals and environmental releases may occur, depending upon the processes and the controls used.

The components must be shipped to the furniture manufacturers where they are assembled into finished pieces of upholstered furniture Workers at the furniture manufacturing facilities could be exposed to chemicals used to meet the draft standard. The exposures could be dermal (e.g., from handling FR-treated fabric or foam) or inhalation (e.g., from inhaling small pieces of fibers or dust or off-gassing from the furniture components). Scrap and waste material will be generated which will have to be either recycled or disposed of through incineration or at a landfill.

The consumers could be exposed to chemicals used to meet the draft standard. The exposure could be through dermal contact with the furniture, mouthing of the furniture by small children, or though the inhalation of dust or emissions from the furniture. Because an old piece of furniture will likely be replaced by another piece, consumers will effectively be exposed to upholstered furniture that meet the draft standard throughout their lives.

Ultimately each piece of upholstered furniture will be disposed of, most likely in a landfill or by incineration. The potential for adverse environmental impacts from disposal can vary depending on the method used to meet the draft standard. For example, some flame retardant chemicals could dissolve in water and migrate with the water. Others might be more tightly bound to soil particles and stay in the landfill. Some FR chemicals are persistent in the environment and may bioaccumulate, which could eventually pose toxicity problems. However, other FR chemicals are likely to breakdown in the environment and have a low potential for bioaccumulation.

Some FR Chemicals Have Caused Health or Environmental Concerns

FR chemicals vary in their properties including the health risks associated with the chemicals and their environmental fate. Some chemicals that have been used for their fire resistant properties have been determined to have unacceptable adverse impacts on health and the environment in some applications. For example, some children's sleepwear manufacturers treated their product with a chemical called tris (2,3,-dibromopropyl) phosphate ("TRIS" or "TDBP") in order to meet a flammability standard. The CPSC later determined that TDBP posed a cancer risk and acted to ban the sale of children's clothing treated with the chemical in 1977.[2] A group of bromine-based FR chemicals called "polybrominated biphenyls" were used as flame retardants until questions regarding their safety were raised in the 1970s and manufacturers voluntarily ended their production. Another class of bromine-based flame retardants was developed to replace them: polybrominated diphenyl oxides ("PBDO," also referred to as polybrominated diphenyl ethers or "PBDEs").[3] However, some PBDOs have been found to be persistent and bioaccumulative.[4] The only U.S. manufacturer of pentabromodiphenyl oxide ("pentaBDO") and octabromodiphenyl oxide ("octaBDO"), the PBDOs that were the subject of the most controversy, ceased production of these two chemicals in 2004.[5] The European Union

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[2] The ban of TDBP or TRIS was blocked by the courts on procedural grounds. However, the Commission's authority to ban TRIS was not at issue. Children's sleepwear manufacturers stopped using TRIS voluntarily.

[3] U.S. Department of Health and Human Services (HHS), Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (Draft for Public Comment), (September 2002). Hereafter cited HHS, ATSDR (2002). p. 292.

[4] Linda S. Birnbaum and Daniele F. Staskal, "Brominated Flame Retardants: Cause for Concern?" Environmental Health Perspectives, Volume 112, Number 1 (January 2004). Hereafter cited "Birnbaum and Staskal (2004)."

[5] "Brominated Flame Retardants To Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

and the States of California, Hawaii, and Maine have recently enacted bans on the use of pentaBDO and octaBDO that will be taking effect over the next couple of years.[6]

Other FR Chemicals Are Widely Used

While some fire resistant chemicals and materials have been found to be hazardous and are no longer used, other FR chemicals continue to be widely used. In the US, the consumption of flame retardant chemicals is estimated to be over 1 billion pounds annually and is increasing at a rate of about 5 percent annually.[7] This includes various bromine, antimony, chlorine, phosphorous, nitrogen, and boron-based FR chemicals. Additionally, there are some fibers where the FR chemical is incorporated into the polymer of the fiber itself or that are inherently fire resistant. These include some modacrylic and melamine fibers.

Flame resistant technology is advancing as manufacturers seek more effective and less expensive methods for meeting various flammability standards as well as to address health or environmental concerns. The same manufacturer that stopped producing pentaBDO is manufacturing a chemical that can be used as a replacement for it. A preliminary assessment by the U.S. Environmental Protection Agency (EPA) indicates that the new chemical is not persistent, bioaccumulative, or toxic to aquatic organisms.[8] A second manufacturer has also introduced an alternative chemical for pentaBDO. In both the cases, the substitute chemicals are bromine and phosphorous-based.

FR chemicals and other materials are already widely used in other goods to which consumers are exposed, including some residential upholstered furniture. Residential upholstered furniture sold in Great Britain must meet the requirements of a flammability standard (referred to as BS 5852") that includes ignition resistance requirements for both cover fabrics and filling materials. Filling materials used in upholstered furniture that is sold in the State of California must meet ignition resistance requirements that are similar to those in the draft standard.[9] Mattresses sold in California must also meet strict flammability standards.[10] Cover fabrics and filling materials used in applications such as airline seating and some commercial and institutional furniture frequently must meet ignition resistance standards. FR chemicals are also

in Maine will take effect on 1 January 2006. The bans in California and Hawaii will take effect on 1 January 2008.

[7] Business Communications Company estimated that U.S. consumption of FR chemicals would reach 969 million pounds in 2003 and was growing at a rate of 5 percent annually (Flame Retardant Chemicals, Report C-004Z, Business Communications Company, Inc., Norwalk, CT, Richard Hilton, Project Analyst, October 1998). The European Flame Retardants Association, citing SRI Consulting, estimated U.S. consumption of FR chemicals to be 1,086 million pounds in 2001 (http://www.cefic-efra.org/frames/f_market_stat.html?=market_stat.html [Information accessed on 4 February 2004. The data were provided in metric tons and converted to pounds using the conversion calculator at www.onlineconversion.com.).

[8] "Brominated Flame Retardants To Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

[9] The standard is the State of California Home Furnishings Bureau Technical Bulletin Number 117 ("CA TB 117").

[10] State of California Home Furnishings Bureau Technical Bulletin Number 603 ("CA TB 603"). The CPSC has proposed a rule that would establish a similar national standard.

widely used in the plastics in television and computer monitor casings, electrical wiring insulation, and in textile products such as sleepwear, protective clothing, draperies, and carpets.

Some Controls to Chemical Exposure May Already Exist

Because the same or similar FR chemicals that will be used to meet a RUF flammability standard are already being used, the exposures and releases similar to the ones that could be attributable to such a standard are potentially occurring now. Controls or procedures that limit worker exposure or environmental releases in those other applications (e.g., ventilation requirements, filters, or protective clothing) are probably applicable to RUF manufacturing as well.

Some chemicals other than FR chemicals that are used in the upholstered furniture industry can also be toxic or have adverse environmental effects if they are handled improperly. Such chemicals are used in various dyes, cleaning solutions, and the manufacture and processing of the various natural and synthetic furniture components. Therefore, furniture and furniture component manufacturers may already have to meet regulatory requirements concerning safe handling and disposal of chemicals. Some of these controls may be applicable to any FR chemicals and materials used.

The hazard communication standard, established by the U.S. Occupational Safety and Health Administration, requires each manufacturer or importer of chemical substances to evaluate the chemicals for health hazards and prepare material safety data sheets ("MSDS") for each chemical substance. The MSDS describes the hazards associated with the chemical and the procedures necessary for its safe handling, including when it is accidentally spilled or released. The MSDS must be provided to all users of the chemical. Any employer using these chemicals must maintain a copy of the MSDS for all hazardous chemicals used in their workplace and train their workers in the safe handling of the hazardous chemicals. The hazard communication standard applies to all chemicals, including flame retardant chemicals.

The Federal Hazardous Substances Act (FHSA),[11] which is administered by the CPSC, requires manufacturers to label any consumer product that contains a substance that could cause harm to consumers through normal or reasonably foreseeable use. The label must describe the hazard and the steps that the consumer must take to avoid the hazard. This would apply to residential furniture if it contained a substance that could present a hazard to consumers through reasonable foreseeable use of the furniture.

It should also be noted that products containing FR chemicals are already used by consumers and products containing FR chemicals are being disposed of in landfills and incinerated. Therefore, for the most part, a flammability standard for RUF would not cause new environmental impacts, but it might intensify impacts that are already occurring. Controls applicable to the disposal of these other products would probably be applicable to furniture as well.

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[11] Codified at 15 U.S.C. §1261-1278.

Methods that May Be Used To Meet the Draft Standard

The draft standard is a performance standard and does not prescribe the methods or treatments that manufacturers must use to meet the requirements. However, CPSC staff believes that some cover fabrics, polyurethane foam, and other filling materials will require some modifications or FR chemical treatments to meet its requirements. Some of the methods that are now available for producing fabrics, polyurethane foam, and barriers and interliners that would meet the draft standard are discussed below. However, the specific treatments that will be used by any individual manufacturer are not known. Moreover, research into flame retardant technology is continuing and new FR chemicals and barrier materials are being developed. Therefore, the strategies used by manufacturers to meet a flammability standard could change as their knowledge and experience increases.

Filling Materials

Polyurethane Foam: Polyurethane foam is one of the most common filling materials used in upholstered furniture; about 350 million pounds of it are used annually. The requirements for polyurethane foam in the draft standard include smoldering small open flame tests. It is believed that about 25 percent of the foam now used in upholstered furniture complies with the State of California standard TB 117, which also includes smoldering and open flame resistance tests.[12] Assuming that polyurethane foam that complies with TB 117 will also comply with the draft standard, this suggests that about 75 percent of the polyurethane foam now used in furniture will require some modification (or the use of a FR barrier) if the draft standard is promulgated.

As noted earlier, pentaBDO was widely used as a flame retardant in polyurethane foam but was found to be persistent in the environment and bioaccumulative. It has since been banned by the European Union and the States of California, Hawaii, and Maine. These bans will be taking effect over the next few years.[13] The only domestic manufacturer of pentaBDO stopped producing it in 2004, effectively ending its use.[14] Therefore, pentaBDO will not be used to meet an upholstered furniture flammability standard.

Chemical manufacturers have developed alternative FR treatments for polyurethane foam. The EPA has preliminarily concluded that at least one of these chemicals is not persistent, bioaccumulative, or toxic, based on several tests it required on the chemical.[15] Alternatives for PBDEs in polyurethane foam include bromine, chlorine, phosphorous, and nitrogen compounds. Through its "Design for the Environment" program, the EPA is working with manufacturers and

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[12] Smith (2005).

[13] The ban in Maine will take effect on 1 January 2006. The bans in California and Hawaii will take effect on 1 January 2008.

[14] "Brominated Flame Retardants to Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

[15] "Brominated Flame Retardants to Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

other stakeholders to coordinate the testing and assessment of FR chemicals intended for use in polyurethane foams to identify the chemicals that are likely to have a low potential for persistence and bioaccumulation in the environment, have low toxicity, are likely to result in low exposure, and whose breakdown products also have low potential for persistence and bioaccumulation and have low toxicity.

The first report of the furniture flame retardancy partnership of the Design for the Environment Program was released in September 2005. It includes a qualitative assessment of the health and environmental concerns for 14 substances that could be used as substitutes for PBDO polyurethane foam. Future plans of this EPA-sponsored partnership include developing additional toxicological data based on the needs determined in the initial assessment. It plans to focus more effort on those substances that become the most widely used flame retardants in polyurethane foam.[16]

CPSC staff conducted a risk assessment of one of the FR products developed as a replacement for pentaBDO in polyurethane foam. The chemical is actually a blend of two aromatic phosphates and two halogenated aryl esters. The staff lacked sufficient toxicity information for the specific chemicals used in the blend and had to use surrogate toxicity data based on toxicity data for similar chemicals in the same chemical class in its analysis. Using the surrogate toxicity data and estimates of what the average daily dose from oral, dermal, inhalation, and ingestion exposures that would result from its use in RUF, the staff concluded that this FR product probably would not pose a hazard to consumers if used in RUF. Toxicity data on the specific chemicals used in the product is required before a more definite conclusion can be made.

Another FR chemical that had been suggested as having applications in polyurethane foam is tris (1,3-dichloropropyl-2) phosphate ("TDCP"). According to a risk assessment performed by the CPSC staff, TDCP could present health hazards to consumers, both cancer and non-cancer, if used in upholstered furniture foam. TDCP is structurally similar to TDBP, which was used as a flame retardant in some children's sleepwear until it was determined that it could cause cancer.

Other Filling Materials: Other common filling materials include polyester fiberfill and cotton batting. Untreated polyester fiberfill is expected to be able to meet the requirements of the draft standard without modification. However, polyester fiberfill is frequently coated with a silicone "slickening" agent to facilitate blowing it into pre-sewn cushions. The silicone agent acts as an accelerant and, therefore, this type of "slickened" polyester will not meet the requirements of the draft standard.[17] Options for meeting the requirement include using a different, non-flammable slickening agent, a different mix of fibers, or encasing the fibers in an FR interliner barrier.

[16] The first report of the Furniture Flame Retardancy Partnership (of the Design for the Environment Program) was published in September 2005. (United States Environmental Protection Agency, Furniture Flame Retardancy Partnership: Environmental Profiles of Chemcial Flame-Retardant Alternatives for Low-Density Polyurethane Foam, September 2005. http://www.epa.gov/dfe/projects/flameret/index.htm).

[17] Smith (2005).

Loose filling materials, such as shredded foam, feathers, and polystyrene beads, will also be subject to smoldering and small open-flame ignition resistance tests. Some of these materials may require the use of FR chemicals or the use of an FR interliner to meet the requirements. Cotton batting used in upholstered furniture is already treated with boric acid and is expected to meet the requirements of the draft standard with no further modification.

Upholstery Cover Fabrics

The draft standard contains a smoldering ignition resistance test for cover fabrics, but does not contain a small open flame ignition test for cover fabrics. The CPSC staff believes that most thermoplastic (e.g., polyester, nylon, acrylic, and polypropylene), wool, leather, and vinyl-coated upholstery cover fabrics will be able to meet the requirements of the draft standard without any modifications. Based on tests conducted by the CPSC laboratory, the fabrics that are expected to fail the smoldering ignition resistance test are the heavier weight fabrics composed primarily of cellulosic fibers (e.g., cotton, rayon, and linen). CPSC staff believes that these fabrics accounted for about 10.3 percent of the cover fabrics used in RUF in 2001.[18] Based on estimates of total upholstery fabric consumption for RUF, about 35 to 50 million linear yards of the upholstery cover fabric used annually would not pass the smoldering ignition resistance test.[19]

FR chemical treatment of all the fabric that would fail the smoldering ignition resistance test would require about 2 to 10.4 million pounds of FR chemicals, assuming that the typical FR chemical application rates used to meet a British open-flame fabric test are used.[20] Furniture manufacturers may also move away from using some of fabrics with a high propensity for smoldering ignition because there are a wide variety of fabrics available that will likely pass the smoldering ignition resistance test without FR chemical treatment. CPSC staff also expect that some furniture manufacturers may opt to use FR barriers instead of modifying the cover fabrics.

Several activities have been undertaken by CPSC staff and others to learn more about the potential health and environmental risks associated with the flame retardant chemicals. These include risk assessments of selected FR chemicals and laboratory analysis of the migration of selected FR chemicals from upholstery fabric treated with the chemicals. The National Academy of Sciences (NAS) evaluated the toxicological risk to consumers of using 16 FR chemicals in RUF.[21] The chemicals or chemical classes evaluated were those that the Flame Retardant

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[18] Smith (2005).

[19] Based on estimates that about 3,250,000 units of upholstered furniture use these severely cigarette ignition prone fabrics and each unit requires 11 to 15 linear yards (Smith (2005)).

[20] FR chemical application rates are from National Academy of Sciences, Toxicological Risks of Selected Flame-Retardant Chemicals, National Academy Press, Washington, DC (2000). The application rates are chemical specific and range from 2 to 7.5 mg/cm^2 or .055 to 0.207 pounds per linear yard. These application rates are the typical rates required to meet the British open flame standard. It is not known how applicable they are to a "smoldering resistance" test.

[21] National Academy of Sciences, Toxicological Risks of Selected Flame-Retardant Chemicals, National Academy Press, Washington, DC (2000).

Chemicals Association identified as potential candidates for use in meeting an open-flame ignition resistance standard for upholstered furniture cover fabrics. The NAS used high (or conservative) exposure assumptions in its assessments. High exposure assumptions would tend to lead to over-estimates of the risks. Of the 16 chemicals or chemical classes assessed by the NAS, it concluded that 8 could be used in RUF with minimal risks to consumers, but that more information was needed on the other eight. The NAS conclusions by chemical are summarized in the Table below.

CPSC staff conducted its own risk assessment on eight of the chemicals.[22] It concluded that four of the chemicals would pose minimal risk in RUF, but more information was needed to properly assess the other four. For six of the chemicals evaluated by both the NAS and the CPSC, the CPSC staff conclusions were similar to those of the NAS. In the case of tetrakis (hydroxymethyl) phosphonium salts, the CPSC staff concluded that more information concerning the exact identity of phosphorous compounds found to be migrating from fabric treated with the chemical was needed before the risks could be properly assessed. In the case of organic phosphonates, the NAS and the CPSC staff based their respective conclusions on two different chemicals in the class. The CPSC conclusions are also summarized in the Table below.

[22] Michael A. Babich and Treye A. Thomas, "CPSC Staff Risk Assessment of Flame Retardant Chemicals in Residential Upholstered Furniture," Directorate for Health Sciences, Consumer Product Safety Commission, Bethesda, Maryland (22 March 2001). Hereafter cited "Babich and Thomas (2001)."

FR Chemicals That Could Be Used in Upholstery Fabrics

Chemical	Found to Pose Low Risks by NAS	Found to Pose Low Risks by CPSC Staff
Antimony Trioxide (AT)	MDN	MDN
Decabromodiphenyl oxide (DBDPO)	Yes	Yes
Hexabromocyclododecane (HBCD)	Yes	Yes
Tris(chloropropyl)phosphate (TCPP)	MDN	--
Tris(1,3-dichloro-2-propyl) phosphate (TDCPP)	MDN	MDN
Phosphonic acid (PA)	Yes	Yes
Tetrakis(hydroxymethyl) phosphonium salts (THPC)	Yes	MDN
Organic Phosphonates		
Dimethyl hydrogen phosphite	MDN	--
Cyclic phonate esters (CPE)	--	Yes
Aromatic Phosphates		
Tricresyl Phosphate (TCP)	MDN	--
2-ethylhexyl diphenyl phosphate (EHDP)	--	MDN*
Chlorinated paraffins (CP)	MDN	--
Molybdates	MDN	--
Antimonates	MDN	--
Zinc Borate	Yes	--
Alumina trihydrate	Yes	--
Magnesium hydroxide	Yes	--
Ammonium polyphosphate (APP)	Yes	--

MDN: More data needed.
-- : Not assessed.
* CPSC staff concluded that EHDP probably would *not* present a hazard to consumers unless the fabric were exposed to non-aqueous cleaners, such as dry cleaning fluid.

The U.S. Environmental Protection Agency (EPA) is expected to issue a significant new use rule (SNUR) that will cover the use of specific FR chemicals in residential upholstered furniture cover fabrics. SNURs are provided for by Section 5(a)(2) of the Toxic Substances Control Act (TSCA). The SNUR would require anyone intending to manufacture, import, or process FR chemicals for use in RUF to notify the EPA at least 90 days beforehand. This notice period is intended to give the EPA an opportunity to review the existing data on the chemical and evaluate its use in RUF. If necessary, the EPA can order additional testing on the chemicals and place restrictions on the use of the chemical in order to prevent unacceptable risks to health or the environment. The specific chemicals that will be covered by the SNUR are not certain at this time. The EPA may exclude some chemicals from the SNUR if it judges that there is already sufficient evidence that the chemicals would not pose a risk to human health or the environment if used in upholstered furniture. It should be noted that the EPA will consider the potential environmental impacts at every stage of the life cycle, including occupational and consumer exposures, environmental releases during the manufacture and use of the furniture, and the ultimate disposal of the furniture. In their analyses, both the CPSC staff and the NAS only considered the potential impacts on consumers using upholstered furniture.

Of the FR chemicals listed above, the ones that are currently thought to be most likely to be used to treat the smoldering ignition prone cover fabrics are phosphonic acid and tetrakis hydroxymethyl phosponium salts (THPC). Both the assessment by the NAS and the CPSC staff suggested that phosphonic acid would probably pose a low level of risk if used in upholstery cover fabrics. The NAS also concluded that THPC would pose a low level of risk. However, the CPSC staff concluded that more information was needed concerning some phosphorous compounds found in extracts from THPC-treated fabrics before the risks could be assessed. However, it was noted that the amount of the phosphorous compounds extracted declined rapidly with subsequent extractions. This suggests that a "wash" or "rinse" procedure could reduce consumer exposure to the compounds.[23] Other alternatives that manufacturers have include the use of an FR barrier or substituting less ignition prone fibers or fabrics.

Flame Resistant Barriers and Interliners

Furniture manufacturers have the option of using flame resistant barriers or interliners that pass the appropriate tests described in the draft standard, in lieu of using complying fabric or filling materials. CPSC staff expects that this option will be used with about 40 percent of the fabrics, by volume, that fail the fabric test, especially those intended for the "high-end" of the retail market. In terms of furniture shipments, this would come to about 4 percent of furniture RUF shipments annually. Research and development of fire-resistant barriers that can be used in residential furniture is advancing. Much of this research was spurred by new flammability standards for mattresses.[24] Materials used to construct barriers to meet the mattress flammability standards might be used to construct FR barriers or interliners for upholstered furniture.[25] Some of the materials that can be used to construct FR barriers and interliners are discussed below.

Modacrylic fibers are composed of acrylonitrile and vinylidine chloride. Antimony trioxide is usually added to the polymer to enhance the FR properties of the fiber. Tests

[23] Babich and Thomas (2001).

[24] CA TB 603 became effective 1 January 2005 for mattresses sold in California. The CPSC has proposed establishing a similar standard nationally.

[25] There are differences between the mattress flammability standard and the draft proposed standard. Therefore, a barrier designed for upholstered furniture is likely to be constructed differently than a barrier designed for mattresses, even though some of the same FR chemicals or materials may be used.

conducted by the CPSC staff for the migration of antimony trioxide and vinylidine chloride from an FR barrier material designed for mattresses confirmed the migration of these chemicals was low when the chemicals are incorporated in the polymer itself.[26] Modacrylic fibers have been used since the 1940s in applications such as children's sleepwear, synthetic fleece, and fake fur and hair.

Melamine fibers are produced from the same type of resin often used for laminates for countertops and in some plastic cooking utensils. It is also used in some protective apparel CPSC staff believe that the toxicity potential of melamine is low. Moreover, when incorporated into polymer fibers, the potential for consumer exposure is also low.[27]

FR viscose is a fiber produced from wood pulp to which sodium silicate and other materials are added. Viscose fibers (e.g., rayon) are widely used. Sodium silicate is also a very widely used chemical. For example, some household cleaning products and detergents contain sodium silicate. One manufacturer of FR viscose asserts that the product is biodegradable and produces low toxic smoke emissions in a fire.[28]

Decabromodiphenyl oxide ("decaDBO) is an FR chemical that could be used in FR barriers. Typically, it is applied to a fabric in a polymer back coating. Antimony trioxide is often used with decaDBO as a synergist. Testing, by CPSC staff, of an FR barrier designed for mattresses that contained decaDBO and antimony trioxide found that the release of decaDBO and antimony trioxide from the barrier was low and not expected to present a health risk to consumers.[29]

DecaDBO is generally considered to be less toxic and less well absorbed than are other PBDOs, such as pentaDBO. DecaDBO is generally not thought to be bioaccumulative although it is persistent. There is also some concern that decaDBO may debrominate or break down into the lower and more toxic forms of PBDOs, such as pentaDBO. This debromination might result from chemical or physical processes in the environment or by metabolic processes when taken up by some animals, such as fish. A recent animal study suggests that decaDBO could be a developmental neurotoxicant. Whether the debromination of decaDBO or the possibility that it is a developmental neurotoxicant are significant problems can not be determined with the available data. Studies on these issues by the EPA and the European Union are continuing.[30]

Boric acid-treated cotton fabric or batting can be used in FR barriers. CPSC staff tested one such barrier designed for use in mattresses and found that consumers were unlikely to be exposed to a sufficient amount of boric acid to present an unacceptable risk of adverse health

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[26] Treye A. Thomas and Patricia Brundage, "Qualitative Assessment of Potential Health Effects From the Use of Flame Retardant Chemicals in Mattresses," CPSC Memorandum to Margaret Neily, 22 September 2004.

[27] Thomas and Brundage

[28] David Perry, "Visil's Inherently FR Nature a Marketing Edge, Company Says," Furniture Today, 28 June 2004. (Available at http://furnituretoday.com)

[29] Thomas and Brundage.

[30] Michael A. Babich, Directorate for Health Sciences, "Brominated Flame Retardant Chemicals," CPSC Memorandum to Dale Ray, 23 June 2004 (DRAFT).

effects.[31] As noted earlier, boric acid-treated cotton batting is already used in some residential upholstered furniture, mattresses, and futons.

Regulatory and Other Protections

Even if some manufacturers use a chemical that is later determined to pose an unacceptable risk to health or the environment, there are established regulatory mechanisms that can limit or remove the hazard. These include using current laws and regulations that are administered by agencies such as the EPA, the CPSC, and others. Other agencies, such as some under the Department of Health and Human Services, do not regulate the use of chemicals but conduct related research on the toxicity of selected chemicals.

There is precedent for using such mechanisms with regards to health concerns caused by flame retardant chemicals. For example, in 1977 the CPSC determined that tris (2,3,-dibromopropyl) phosphate, which was used by some manufacturers to meet a children's sleepwear flammability standard, posed a cancer risk. To eliminate this risk, the Commission acted to ban the sale of children's clothing treated with the chemical.[32] However, the Commission did not alter the flammability standards for children's sleepwear; it only acted to remove one option for meeting the standard.

The U.S. Environmental Protection Agency has comprehensive powers to regulate the use of toxic chemicals under the Toxic Substances Control Act (TSCA).[33] As discussed earlier, the EPA is developing a significant new use rule (SNUR), under Section 5(a)(2) of TSCA, which is expected to cover FR chemicals that are candidates for use in residential upholstered furniture cover fabrics.

The EPA's New Chemical Program, which is also mandated by Section 5 of TSCA, requires any one seeking to manufacture or import a new chemical to notify the EPA at least 90 days in advance. This allows the EPA the opportunity to determine whether there is enough information to determine whether the chemical may have significant adverse impacts. And if it is determined that the chemical could have significant adverse impacts or if there is not sufficient information to make this determination, the EPA can establish controls on the use of the chemical.

Other EPA activities involve researching and monitoring the use of certain chemicals, including some FR chemicals. These include some voluntary programs, in cooperation with chemical manufacturers, such as the "Voluntary Children's Chemical Evaluation Program" and the "High Production Volume Challenge Program."[34] If information is developed during these activities suggesting that a flame retardant could be toxic or have adverse environmental effects,

[31] Thomas and Brundage (2005).

[32] The ban of TRIS was blocked by the courts on procedural grounds. However, the Commission's authority to ban TRIS was not at issue. Children's sleepwear manufacturers stopped using TRIS voluntarily.

[33] 15 U.S.C. s/s 2601 et. seq (1976).

[34] See the Federal Register, Vol. 65, No. 248, pp. 81686-81718, (26 December 2000).

the EPA could impose controls on the use of the chemical to ensure human or environmental safety. As discussed earlier, through its "Design for the Environment" program, EPA is helping to coordinate the testing of FR chemicals that may be used to replace PBDOs in polyurethane foam in order to identify alternatives that are expected to have low impacts on health and the environment.

If the use of a particular FR chemical or material in RUF could pose a hazard to consumers, the CPSC has authorities under the Consumer Product Safety Act (CPSA)[35] and the FHSA that can be used to prohibit the use of the substance in applications that could cause health hazards. For example, the CPSC could ban the use of furniture components treated with a particular chemical, if its use in that application could expose consumers to health hazards.

The National Toxicology Program (NTP) of the Department of Health and Human Services ("HHS") coordinates the toxicological review and testing of chemicals for agencies under the HHS. Federal and state agencies, academics, advocacy groups, industry representatives, and private citizens may nominate substances for testing under the NTP. The NTP chooses substances for further testing and evaluation based upon factors such as the extent of human exposure and the degree of suspicion of toxicity and the extent of any toxicological data gaps. Agencies such as the EPA and CPSC may nominate chemicals for testing and use the results of NTP testing to regulate a substance if the results indicate that it could be hazardous. The NTP has examined or is evaluating some flame retardant chemicals, including several PBDOs.

Several advocacy groups have researched and monitored flame retardants and other chemicals for human and environmental toxicity. These parties often publicize their findings and advocate for regulations when they find potential problems.[36] Manufacturers also have incentives to investigate the potential toxicity of their products, both to avoid liability for damage caused by their products and to ensure that they have other marketable products should some be removed from the market. As previously noted, some manufacturers have voluntary stopped the manufacture of flame retardants when questions have been raised about their toxicity or environmental effects. Chemical manufacturers are actively developing alternative chemicals and are cooperating with the EPA to ensure that the substitutes do not pose unacceptable risks to health or the environment.[37]

In a plausible "worst case" scenario, a particular chemical or material that is used by some manufacturers to meet the draft standard could be determined to pose an unacceptable health or environmental risk. For example, new evidence might show that the potential consumer exposure to a chemical or material could raise the risk of developing a particular type of cancer above some threshold of concern (e.g., one in a million) or could exceed the level that

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[35] Codified at 15 U.S.C. §2051-2084.

[36] For example, the Environmental Working Group has recently published several reports on PBDE flame retardants: Tainted Catch (2003), Mothers Milk (2003), and In the Dust (2004). These are available at http://www.ewg.org.

[37] "Brominated Flame Retardants to Be Voluntarily Phased Out," U.S. Environmental Protection Agency News Release (3 November 2003), available at http://www.epa.gov.

toxicologists consider to be an acceptable daily intake to avoid other chronic diseases or injuries. Or, new evidence could show that a particular FR chemical used to meet the standard bioaccumulates, that is that there are increasing concentrations of the chemical in living organisms.

If a chemical or material used to meet the draft standard is determined to present an unacceptable risk, there are regulatory mechanisms that can be used to limit the specific risk. For example, the EPA, the Occupational Safety and Health Administration (OSHA), or the CPSC could establish controls or bans on the use of the specific chemical or material as appropriate. Such mechanisms have been used when other chemicals used in consumer products have been found to have unacceptable risks. For example, as discussed previously, a flame retardant used in children's sleepwear (tris (2,3,-dibromopropyl) phosphate was found to pose an unacceptable risk of cancer. As noted earlier, pentaBDO, which has been used as an FR chemical in polyurethane foam, has been found to bioaccumulate. In both cases, regulatory authorities, here and abroad, undertook investigations of the risks, and in some instances took steps towards regulating the use of the chemical. And in both cases, manufacturers took steps to stop using the chemicals before final bans or regulations went into effect.[38] Moreover, in both cases, substitutes have been developed. It should also be noted that both of the chemicals cited above were in use prior to the establishment of the EPA, CPSC, and OSHA in the 1970s.

In summary, several regulatory agencies, advocacy groups, and industry participants have mandates or interests in monitoring the use of chemicals that may be toxic or have adverse impacts on the environment. Taken together, these regulatory agencies, advocacy groups and industry participants provide mechanisms for banning or establishing other controls on the use of substances that are determined to pose unacceptable risks to human health or the environment.

Alternatives Considered

The CPSC staff have examined several alternatives to the draft standard. With the exception of a "no action" or "labeling only" alternative, all of the alternatives considered would require the use of some FR chemicals or barriers. However the specific chemicals used and the volume of chemicals used would vary among the alternatives.

The 2001 CPSC Staff Draft Small Open Flame Standard

In 2001, the CPSC staff developed a draft flammability standard that called for a small open-flame testing of upholstery cover fabrics. The 2001 draft standard called for cover fabrics to be exposed to a small open flame for 20 seconds. To pass, all combustion would have to cease within 2 minutes after the flame was removed from the fabric. The 2001 draft did not include any

[38] Sleepwear manufacturers stopped using tris in children's sleepwear even though a CPSC ban was not finalized. The manufacturers of CCA voluntarily requested that the EPA to cancel their registrations of CCA, effectively banning the product. Finally, the only US manufacturer of pentaDBO has announced that it is voluntarily phasing out its production.

test for filling materials. It did include a barrier option similar to the one included in the current, or 2005, draft standard.

Promulgating the 2001 draft standard would result in a different mix of FR chemicals being used, but it is uncertain if the total amount of FR chemicals used would be different. About 66 percent of the total yardage of cover fabrics would have required FR chemical treatment to meet the 2001 draft standard, including most thermoplastic and cellulosic fabrics. Therefore, this standard could have resulted up to 45 million pounds of FR chemicals being used to treat upholstery cover fabric.[39] The 2005 draft standard would result in about 2 to 10 million pounds to treat cover fabrics. However, the 2005 draft standard also includes requirements for filling materials, which could require a substantial amount of FR chemicals.

Furniture Industry Coalition Proposal

In May, 2004, the American Furniture Manufacturers Association (now known as the "American Home Furnishings Alliance" or "AHFA") proposed a standard to CPSC that included smoldering ignition resistance requirements for all upholstered furniture components and 5-second open flame ignition resistance requirements for cover fabrics and some filling materials used in cushions. The AHFA proposal excluded fiber batting, commonly used in back cushions, from the open flame ignition resistance requirements.

AHFA estimated that about 80 percent of the upholstery cover fabrics used in the U.S. would fail its proposed test without FR chemical treatment.[40] Therefore, the AHFA proposal would result in more FR chemicals being used to treat cover fabrics than would the draft standard. The requirements for polyurethane foam in the AHFA include an open flame ignition resistance test. Therefore, the use of FR chemicals for polyurethane foam to meet the AHFA proposed standard could be similar to those that would be used to meet the CPSC staff's draft standard. However, as noted, the AHFA proposal does not include open flame ignition resistance requirements for polyester fiber and other materials used in back cushions, which would result in fewer FR chemicals being used than under the draft standard. However, this would also reduce the effectiveness of the standard.

Adding a Small Open Flame Test for Fabric to the Draft Standard

The staff considered including a small open flame test for cover fabrics in the draft standard. The test would have involved exposing the cover fabric covering FR polyurethane foam to a small open flame for 10 seconds. A failing test would be one in which the total mass loss of the fabric and foam exceeded 20 percent. This standard would be similar to the State of California draft standard TB 117+. TB 117+ is a draft revision of TB 117, which is the current

[39] Assuming that 66 percent of an estimated 333 million yards of fabric require FR treatment at an application rate of 0.207 pounds per yard.

[40] Comments of the American Furniture Manufacturers Association to the U.S. Consumer Product Safety Commission, December 22, 2003. (Available at: http://www.cpsc.gov/library/foia/foia05/pubcom/smolderpt1.pdf.)

upholstered furniture flammability standard in California. TB 117+, however, has not been officially proposed.

Limited testing by the Directorate for Laboratory Sciences indicates that a wide variety of fabrics would fail this small open flame test that pass the cigarette ignition resistance test. Therefore, the inclusion of a small open flame test would likely result in more cover fabrics being treated with FR chemicals. The staff estimates that the inclusion of this test would require approximately 20 million additional pounds of FR chemicals per year over the draft standard.

Adopting only the Smolder Ignition Tests of the Draft Standard

Some industry stakeholders suggested that CPSC only include those performance tests related to smoldering ignition resistance because most of the fires originating in upholstered furniture are the result of smoldering ignitions. CPSC staff believes that most filling materials, including polyurethane foam, cotton batting, and polyester fiberfill would probably pass the smoldering ignition tests without modification. Therefore, the only FR chemicals or materials required would be to treat the roughly 10.3 percent of the cover fabrics that are not expected to pass the smoldering test or for manufacturing FR barriers to use with smoldering ignition prone fabrics. However, the smoldering ignition resistance tests were developed with the assumption that the open flame ignition resistance tests for filling materials would be included in the standard and would play a complementary role in reducing ignitions. If the open flame tests for filling materials are not included, it might be necessary to develop more stringent smoldering ignition requirements.[41]

Eliminating the Open Flame Tests for Loose Filling Materials

Loose polyester fiberfill will not pass the open flame test without modification, such as the inclusion of FR fibers or the encasement of the polyester fibers in an FR interliner, but are likely to pass the smoldering ignition resistance tests. Eliminating the open flame tests for loose filling materials would reduce the need for FR chemicals or materials for loose filling materials. However, eliminating the open flame tests for loose filling materials from the draft standard would likely reduce the benefits of the standard.[42]

"No Action" or Adoption of Only a Labeling Rule

The Commission could opt not to promulgate a standard or adopt a rule requiring only label warning of the flammability danger of upholstered furniture. Neither of these options would likely reduce the number of fires originating in upholstered furniture. However, taking no action or not promulgating a standard would reduce the volume of FR chemicals that are used to treat

[41] Smith (2005).

[42] Smith (2005).

RUF components compared to any of the other options considered. However, some use would still occur to meet other standards, such as the State of California standard (CA TB 117).

Additionally, not promulgating a standard would not reduce the environmental damage that can result from residential fires. In addition to the immediate death and injuries, the burning of the various materials that are be found in houses (e.g., building materials, furniture, polyvinyl chloride, electrical and electronic equipment, and so on) can create toxic compounds that are released into the environment. These can include dioxins, hydrogen cyanide, and polycyclic aromatic hydrocarbons.[43] Water used for fighting fires is contaminated with the various pollutants that are created in house fires. This water may carry these pollutants into the streams, rivers, and ground water. Such pollution could be reduced if fewer fires occur. To the extent that ignition resistance standards for RUF would reduce the number or severity of residential fires, these adverse environmental impacts would be reduced. Furthermore, the fire itself and the creation of toxic compounds may have substantial adverse effects on the health and safety of firefighters.

Summary and Conclusion

Manufacturers will have flexibility in meeting the performance requirements of the draft standard, thus the extent to which each of the various FR chemicals and other alternatives for meeting the requirements (e.g., using FR barriers or substituting less ignition prone materials) will be used is uncertain. Although some data gaps and uncertainties in our knowledge of some of the health and environmental impacts exist, there are FR chemicals and flame resistant materials that, based on currently available data, are not expected to pose unacceptable risks to the environment and that are widely used in other applications. Therefore, manufacturers probably have alternatives for meeting an upholstered furniture ignition resistance standard that will not result in unacceptable adverse impacts to the environment or human health. Moreover, government agencies, advocacy organizations, academics, and even chemical manufacturers are monitoring and conducting research on the environmental and health impacts of different FR chemicals and other materials. There are regulatory and other mechanisms that can be used to control the use of specific FR chemicals if they are found to pose hazards to the environment or health.

[43] Petra Andersson and Margaret Simonson, "Fire safety of upholstered furniture, A Life-Cycle Assessment – Summary Report," SP Swedish National Testing and Research Institute. This a summary of SP Report 2003:22, prepared for the European Flame Retardants Association and IKEA.

APPENDIX

Sources Consulted

This assessment is largely the result of the analyses of CPSC staff experts. These experts include PhD chemists, toxicologists, and pharmacologists. CPSC staff have conducted numerous assessments of FR chemicals and materials since work began on this project in the mid 1990s. This work has included chemical migration testing of some FR materials by the CPSC Directorate for Laboratory Sciences. Some of this work is referenced in this environmental assessment.

CPSC staff have worked and consulted with staff at the U.S. Environmental Protection Agency in developing a SNUR for FR chemicals that would be used in upholstery cover fabrics.

On May 5 – 6, 1998, the Consumer Product Safety Commission held a public hearing on health and environmental concerns about the use of FR chemicals in residential upholstered furniture. Among those testifying or submitting comments were officials and representatives from the U.S. Environmental Protection Agency, The Occupational Safety and Health Agency, flame retardant chemical manufacturers, fabric and furniture manufacturers, and professional firefighters.