POST-HEARING COMMENTS OF

THE UPHOLSTERED FURNITURE ACTION COUNCIL

ON THE TOXICITY OF FLAME RETARDANT

CHEMICAL TREATMENTS FOR

UPHOLSTERY FABRICS

August 3, 1998

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I. INTRODUCTION

The Upholstered Furniture Action Council (UFAC) testified before the Consumer Product Safety Commission (CPSC) at the agency's May hearing on the toxicity of flame retardant (FR) chemicals that might be used on upholstery fabric. During the question and answer session, the Commissioners and staff made several requests for information from Joe Ziolkowski, the Executive Director of UFAC and James Norris, Ph.D., a Board-certified toxicologist who has reviewed this issue extensively for UFAC. The purpose of these comments is to respond to those specific requests. In addition, they offer information on some points made by other witnesses at the hearing.

The hearings reinforced UFAC's conviction that insufficient information has been provided for the record on both the health effects of particular FR chemicals and their potential bioavailability when used on upholstered fabrics. There was a notable consensus among the witnesses that FR backcoating would be the primary mechanism of compliance with a small open flame standard of the type proposed by CPSC staff. There was also widespread acknowledgement of the toxicity of many of the chemicals which would be employed for that purpose.

Thus, the central issues remain: whether workers and consumers could be exposed to FR chemicals contained in a backcoating; whether the impact over time of external factors such as abrasion, heat, sunlight, solvents and body fluids could increase the potential for such exposure; and whether exposure would lead to the bioavailability of these toxins.

The dearth and inconsistency of information on these critical issues have been attributed to proprietary business considerations, to the fact that CPSC staff reviewed a different universe of FR chemicals than did the Flame Retardant Chemical Association (FRCA), to the obstinancy of the U.S. furniture and textile industries, and to misconceptions on the part of governments and consumers in continental Europe. The result, in any case, is an administrative record that does not provide the assurances for public health and safety that UFAC views as the appropriate public policy to move forward on a matter of this massive scale and potential for adverse consequences.

II. FR BACKCOATING WILL BE THE PRIMARY COMPLIANCE OPTION

Contrary to assertions that, "some manufacturers might well choose to meet the standard by using chemicals"[1], it is very clear that FR treatment of fabrics is the CPSC staff's contemplated mechanism of compliance with their proposed test method. The imposition of this test method will have the practical effect of mandating the FR backcoating of virtually all residential upholstery fabrics.

This conclusion is reflected in the staff's laboratory testing, where all 27 of the chairs subjected to the agency's proposed flame test "did not prevent ignition or cause self-extinguishment of cover fabrics."[2] These included chairs manufactured to the UK standard which were evidently constructed with interliners, but without FR treatment of the outer fabric.

Further, the Briefing Package presents detailed descriptions of full-scale and bench scale testing of UFAC, TB-117, and UK compliant chairs, none of which were recommended as constructions.[3] In contrast, staff concluded that:

> *The most promising method of reducing the risk to consumers from small open flame ignited upholstered furniture fires involves FR treatments in cover fabrics.*[4]

The witnesses at the May 5-6 hearing also concurred on this point. After discussing the technical feasibility of "inherently flame resistant fibers" and other treatment methods, representatives of the UK government and the chemical industry acknowledged that FR backcoatings are by far the most prevalent way of passing a

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[1] CPSC Chairman Brown's letter to The Honorable Gerald Solomon, Chairman, House Rules Committee, July 7, 1998.

[2] U.S. CPSC, Regulatory Options Briefing Package on Upholstered Furniture Flammability, October 28, 1997, p. 21.

[3] *Id.* at p. 21.

[4] *Id.* at p. 30.

small open flame standard.[5] Options for compliance with the CPSC's proposed test method would be even more limited, because, unlike the British regulation, it does not provide an interliner exemption for predominantly cellulosic fabrics.

In responding to the Commission's request for more information on the health effects and bioavailability of fabric flame retardants, let us not harbor any illusions that FR backcoatings will be one of a number of compliance "options". The administrative record and the nature of the CPSC proposed small open flame test dictate that FR chemical backcoatings on hundreds of millions of yards of upholstery fabrics would be the regulatory result for the tens of millions of upholstered furniture products sold in this country each year. This underscores the gravity of the public health and environmental questions which we are now confronting.

III. THE POTENTIAL HEALTH RISK OF FR CHEMICALS

A. Deficient Bioavailability Data

At the hearing, all witnesses agreed that data on the bioavailability of the identified FR chemicals in an upholstery fabric medium were necessary in order to assess their potential toxicity. As Dr. Norris indicated in his response to Mr. Medford,[6] focusing attention on bioavailability is a viable approach for the assessment of the potential health impact of FR chemicals. However, he cautioned that the assessment must be complete so that all of the potential exposure routes and mechanisms of bioavailability are examined. Dr. Norris identified a number of concerns specific to the application of FR chemicals to upholstery fabric, including the oral route of exposure, skin penetration, bioavailability, measurement of bioavailability, and chronic toxicity, which were not adequately addressed in the staff briefing package. As a consequence, the staff's current methodology would not erect meaningful safeguards against FR treatments with unacceptable toxicological effects and bioavailability.

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5 Transcript of Public Hearing on Flame Retardant Chemicals. U.S. Consumer Product Safety Commission, May 5, 1998 at pp. 84, 256.

6 *Id.* at 180 - 181.

Given the staff's reliance on a bioavailability approach to the issue of the FR health impact, it is noteworthy that virtually none of the FR chemicals in the CPSC Briefing Package had comprehensive bioavailability data. According to the preamble to the agency's Chronic Hazard Guidelines, "... the default value should be used when there are no adequate data which would lead to an alternate approach" and "The default value for bioavailability assumes that 100 percent of a substance to which a person is exposed will be absorbed."[7] CPSC's own guidelines stipulate, given the lack of bioavailability data, that a default value of 100 percent should have been incorporated for assessing the risk of these FR chemicals listed in the CPSC briefing package. However, the staff employed several assumptions discussed below with the result that the bioavailability for the FR chemicals was equated to zero. Inexplicably, the staff failed to follow the Commission's own guidelines.

For all of the FR chemicals, except for antimony trioxide, the CPSC staff utilized several assumptions regarding these chemicals' bioavailability. Those assumptions included:

(1) the molecule is large so it is less likely to migrate to the top of the fabric and; hence the FR chemical will not transport across the dermal layer of skin into the circulatory system;[8]

(2) the molecule is charged (ionic) and hence the FR chemicals will not be able to transport across the dermal layer of skin into the circulatory system;[9]

(3) the oral route of exposure is ignored; the toxicity and bioavailability of the FR chemicals were only considered via the dermal route of exposure;[10] and

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[7] 57 Fed. Reg. 46649 (1992).

[8] Briefing Package, *supra*, at p. 377.

[9] Briefing package, *supra*, at p. 378.

[10] Briefing package, *supra*, at pp. 371-379.

(4) the dermal LD_{50} value is compared to the oral LD_{50} value to assess bioavailability with the assumption being that if the dermal LD_{50} value was large, then little or no dermal absorption would occur.[11]

Dr. Marcia Hardy of Albermarle Corporation stated that a complete toxicity data set would be presented by Dr. Piccirillo on the 24 FR chemicals that FRCA identified as most appropriate for upholstery fabric.[12] However, no such comprehensive data set was presented by Dr. Piccirillo and, according to the Office of the Secretary, none were submitted. Procedural fairness should dictate that UFAC be given the opportunity to obtain and review this material, should it be submitted.[13]

The authors of the draft DTI study[14] admitted that the United Kingdom did not have statistics on the long term human health impacts of exposure to the three FR chemicals identified as being used in upholstered furniture in that country. The lack of long-term studies meant that a serious limitation had been placed on a complete evaluation of these FR chemicals. Mr. Mann conceded that "[b]oth our review for DTI and Dr. Mishra's review [for CPSC] suffer from a lack of hard data on bioavailability."[15] Further, a co-author stated that "... our level of confidence is

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[11] Briefing package, *supra,* at p. 377.

[12] Transcript of Public Hearing on Flame Retardant Chemicals, U.S. Consumer Product Safety Commission, May 6, 1998, at p. 8.

[13] Dr. Hardy stated that some of the FR chemicals in Dr. Norris' report were not considered appropriate by FR chemical manufacturers for use on upholstery fabrics. However, the FR chemicals were not proposed by Dr. Norris to be appropriate. Dr. Norris's assessment was related only to the FR chemicals presented in the CPSC Briefing Package.

[14] The study was commissioned by the Consumer Safety Unit of the British Department of Trade and Industry (DTI) to address the use of flame retardants in consumer products generally. Its review overlaps with CPSC's review only with respect to three FR chemicals: antimony trioxide, decabromodiphenyl oxide, and melamine. A. Mann, Assessment of the Toxic Risk from Direct Exposure to Flame Retardants in Upholstered Furniture, 1 (1998).

[15] *Id.* at p. 2.

constrained by incomplete information on the long term human exposure toxicology and environmental impact of flame retarded product and the lack of any life-cycle risk assessment experience in this field."[16] The Environmental Defense Fund has highlighted the importance of such chronic studies when evaluating toxic exposures:

> *To assess the safety of chemical use in such contexts, it is important to have data from chronic toxicity tests; i.e. tests investigating the effect of exposure to the chemical over substantial periods of time.*[17]

Mr. Mann concluded that "More investigations are advisable, particularly with respect to bioavailability. And here I refer mainly to the need to find out, particularly how fast the flame retardants are bound to the matrix."[18] This concern will be discussed in the following section.

B. Inadequate Exposure Data

The FRCA notes correctly that flame retardants have, to this point, been incorporated into a wide variety of product applications. UFAC has never questioned that some such applications may be safe and appropriate. We have raised questions about their use in upholstery fabric because fabrics are in intimate contact with workers and consumers and may have greater exposure to some external factors, such as abrasion, sunlight, cleaning solvents, and body fluids. Indeed, it was a similar fabric medium, specifically children's sleepwear, where the toxicological aspects of flame retardants first received widespread scrutiny.

We all agree that flame retardant chemicals have a significant role to play in public safety. The need to balance the utility of FR chemicals with the appropriateness of their application was highlighted by the Environmental Defense

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[16] G. Stevens, Considerations of Balance of Risk in Realizing the Benefits of Flame Retardants in Upholstered Furniture, 24 (1998).

[17] W. Pease, D. Roe, et al, *Toxic Ignorance,* Environmental Defense Fund, p. 16, 1977.

[18] Transcript of May 5, *supra,* at p. 71.

Fund. This group accurately described the Commission's dual role in protecting consumers:

> *As both promoter and regulator of flame-retarded fabrics, the Consumer Product Safety Commission must develop a program that recognizes the important tradeoffs between protection against burn injury and the protection against the long-term side effects of the flame retardant chemicals used in consumer products. The stakes are very high; the problems have immense implications to the health of this nation.*[19]

Several witnesses from FRCA stated that any FR chemical backcoating of upholstery fabric would not result in exposure to consumers because of the following factors:

(1) the FR chemicals would be in the backcoating which covers the FR chemicals to prevent contact with consumers;[20]

(2) the FR chemicals must become soluble in water before human exposure can occur;[21] and

(3) the FR chemicals will chemically bond to the fabric and thus prevent contact with consumers.[22]

No data were presented to support the contention that the backcoating will prevent human exposure to the FR chemicals contained therein. In fact, a well-mixed backcoating could result in the FR chemicals being distributed equally throughout the backcoating, which includes the surface of the backcoating. The

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[19] Statement of Dr. Robert H. Harris and Mr. Robert J. Rauch, Environmental Defense Fund, before the House Committee on Interstate and Foreign Commerce, September 26, 1977, pp.17-18.

[20] Transcript of May 6, *supra*, at pp. 19, 20, 21, 33.

[21] Transcript of May 6, *supra*, at pp. 25, 48.

[22] Transcript of May 6, *supra*, at p. 16.

protrusion of the FR chemicals through the surface of the backcoating would mean that consumers have the potential for exposure to these chemicals. Thus, "encapsulation" of the FR chemicals in the backcoating does not necessarily prevent exposure.

Mr. Ziolkowski amply demonstrated this concept with his fabric sample that were treated with a backcoating containing a sweetener. He reported that, by licking the fabric, the sugar could be tasted.[23] This suggests that the "encapsulation" of this chemical in the backcoating is not complete. FR chemicals in a backcoating may not be completely encapsulated either.

Ingestion of backcoating particles that have abraded from upholstered furniture fabric has not been considered by the CPSC staff. Data should be provided to demonstrate that, if ingested, backcoated materials can withstand the digestive process so as not to release the FR chemicals.

FRCA also stated that many FR chemicals are insoluble in water. Therefore, their insolubility would prevent human exposure to these chemicals.[24] However, hydrophobic chemicals can be absorbed from the digestive tract and through the skin.

The extraction of FR chemicals from the upholstery fabric is another means by which exposure could occur. The CPSC staff did generate limited test data with its water and acid extraction testing. They contend that these results show that the FR chemicals were very unlikely to be extracted from the fabric. However, Mr. Mann said that the agents used by the agency were not the most appropriate way to assess exposure. Rather, body fluids would seem to be appropriate.[25] Mr. Mann indicated that additional work was advisable to assess the possible degree of oral exposure.[26]

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[23] Transcript of May 5, *supra,* at pp. 122-123.

[24] Transcript of May 6, *supra,* at p. 49.

[25] Transcript of May 5, *supra,* at p. 108.

[26] Transcript of May 5, *supra,* at p. 6.

The position of the FRCA that FR treatments will molecularly bond to the fabric needs to be clarified. FR backcoatings are applied as a foam and simply dry on the fabric with varying degrees of penetration. The bond between the FR backcoating and the fabric is simply a mechanical bond.

C. Brominated Flame Retardants

Dr. Hardy said, in response to a question, that Germany and the Scandinavian countries allow the sale of brominated flame retardant chemicals.[27] While that may be accurate in a narrow, legalistic sense, the regulatory movement of these countries is widely understood to be in the opposite direction. Comments received by CPSC in the present rulemaking from the Austrian Ministry for Economic Affairs, for example, pointed to concerns about indoor air pollution and toxic exposures generated by these FR chemicals.

It has been noted that the German government rejected an EU "harmonization directive" which would have extended a United Kingdom type flammability standard to the continent. In comments to the European Commission, the Consumer Council of Deutsches Institut für Normung (DIN) concluded that:

> *...the process of equipping upholstered furniture or mattresses with these chemical substances poses a considerable risk for the health of workers through some cancerous and mutagen compounds. Materials equipped with flame retardant substances can only be recycled in a very limited way and must in the end be disposed of as 'Toxic Waste' in a special garbage incineration plant. There is only limited information available on environmental impacts through the presently used flame retardant substances. The general use of flame retardant substances in upholstered furniture and mattresses is very questionable.*[28]

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[27] Transcript of May 6, *supra,* at p. 43.

[28] Translation from *Schwerentflammbarkeit von Materialien und Produkten Erenntnisse und Schlußfolgerungen,* Consumer Council of Deutsches Institut für Normung (DIN), p. 9.

The German EPA's activities in this area were reported by a technical publication last year.

> *The German EPA, Umweltbundesamt, is planning a large scale investigation of bromine flame retardants which will form the basis of a regulation of the area. The Germans have lost patience with the EU ten year attempt to look into the problem, and will now make their own national regulations, explains Cornelia Elzner from the Office of Compound Related Issues in the Umweltbundsamt.*[29]

Similar concerns have been raised by authorities throughout Europe. The Nordic Council, formed in 1952 to promote cooperation among the parliaments and governments of Denmark, Iceland, Norway and Sweden, recently issued a study on this topic. The Council reported that the halogenated flame retardants, in particular brominated biphenyl, have been targeted because of environmental and health concerns.[30] At a minimum, they recommended that brominated flame retardants be avoided and noted that these flame retardants are in the process of being phased out of the Nordic textile industry.

The Ingeniøren, published by the Society of Danish Engineers, summarized the trend in "[c]ountries, like Sweden, Germany and Holland, [which] have taken steps to limit the use of the bromine flame retardants."[31]

Very recent research conducted by the Russian National Academy of Sciences in Moscow emphasizes hazards in the areas of combustion toxicity and occupational exposure for textile employees:

> *The halogenated fire retardants used to decrease fire hazard of polymeric materials based on polyolefins, polyethylene and polypropylene above all, tend to be banned because high toxicity and corrosiveness of produced smoke and suspecting of evolution of*

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[29] Ingeniøren, September 5, 1997, at p. 2.

[30] *Environmental Impact of Consumer Goods: A guideline for specific assessments,* The Nordic Council, 1997, at p. 148.

[31] *While the Red Warning Lights are Blinking,* Ingeniøren, August 1, 1997.

extremely toxic compounds at the stage of incorporation into polymers.[32]

The perspective of many European policy makers was expressed in written testimony to the CPSC from Ulrich Girrbach, a Ph.D. chemist with the leading synthetic textile manufacturer, Trevira. Dr. Girrbach's membership on the fabric flammability committees of the European Standardization Institute (CEN), the International Standardization Institute (ISO), and other bodies gave him special insight into the European deliberations on the FR treatment of upholstery.

> *In 1990, the EU Commission proposed a harmonization directive in order to eliminate what was effectively a trade barrier created by the United Kingdom legislation on the European furniture market. ...The proposed increased use of FR chemicals created grave concerns, especially among consumers in Germany and Austria. The available information on possible long term effects of FR products in such close proximity to the human skin was considered unsatisfactory. There were also serious questions about fabric and furniture waste and discarded products, particularly given the bulk, cost, and long term life of these products in the home.*[33]

There have been recent questions raised in the scientific community about the bioavailability of brominated flame retardants in more traditional applications that were generally assumed to be safe. These data suggest that brominated FR chemicals and byproducts such as PCB's and furans can be released into the environment. These FR chemicals consisted of polybromine diphenyl ether and tetrabrombispenol-A. Brominated isomers were found in air samples from offices.[34]

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[32] N. Bakeev, *Flame Retarded Polyolefins With Low Content of Halogen,* Institute of Synthetic Polymeric Materials, Russian Academy of Sciences, 1998.

[33] Statement of Dr. Ulrich Girrbach to the U. S. Consumer Product Safety Commission for the Public Hearing on Flame Retardant Chemicals that may be suitable for use in Upholstered Furniture, May 5-6, 1998 at p. 3.

[34] L. Bergman, et al, *Flame Retardants in Plasticizers or Particulates in the Modern Computerized Indoor Environment,* 33 Organohalogen Compounds, 414-419 (1997).

Another health and safety aspect of brominated flame retardants was raised at the hearing. A question was asked whether polybrominated dibenzo-p-dioxins and -furans (PBBDD/F) were present after a fire in which brominated flame retardants were contained in the fire load. The following article is offered as a source of some information.[35] In Germany, three private residences were analyzed after a fire for PBBDD/F. PBBDD/F were found in the range of 1 to 173 ug/kg with the exception of a TV case, which contained 14,910 ug/kg PBBDD/F. This latter value exceeded the limits specified in Germany for "hazardous compound regulation."

D. Chemicals Not Reviewed in the Staff Briefing Package

Dr. Hardy testified that the FR chemicals listed in the CPSC briefing package were not considered appropriate by the FR chemical manufacturers for use on upholstery fabrics.[36] As an alternative to the CPSC list, the FRCA has proposed another list of 24 FR chemicals that their members feel are likely to be used in this application. Those 24 chemicals have not been the subject of a toxicity review by either the agency or the public. Under the circumstances, that would seem to be a critically important step in this proceeding.

We appreciate Mr. Kidder's point that the "producers of specific [FR] products are in the best and most responsible position to elaborate on the toxicity and bioavailability of the chemicals."[37] However, very little information has been forthcoming. Even if some of the data is claimed to be proprietary, every effort should be made to "sanitize" it and release it for public comment. The Environmental Defense Fund identified the obstacles that unreleased proprietary data presents to effective chemical risk assessment.

> *For some chemicals there is undoubtedly private information...for example, tests on specific chemicals that major manufacturers have performed, or paid for, which to date have not been made available to*

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[35] V. Zelinski, W. Lorenz, and M. Bahadir, *Brominated flame retardants and resulting PBBDD/F in accidental fire residues from private residences,* Chemosphere 27(8): 1519-1528, (1993).

[36] Transcript of May 6, *supra,* at pp. 7-8.

[37] Transcript of May 5, *supra,* at p. 226.

the public. ...For purposes of assuring the public about the safety of specific chemicals, non-public data are of no real value. To rely on them is to ask the public to take chemical safety on faith--the exact opposite of the intent of modern toxic chemical control laws passed by Congress since 1970.[38]

In his oral testimony, Dr. Piccirillo said that he had reviewed toxicological data submitted by manufacturers to him. In light of Dale Ray's request that all data be submitted to the agency, it is hoped that the data Dr. Piccirillo reviewed will be made a part of the record of this proceeding and available to all parties for their review and comment.

Another obstacle that prevents the public review of toxicological data is the lack of readily available CAS numbers for the 24 chemicals identified by FRCA as being suitable for upholstery fabric applications. No CAS numbers were included in either the FRCA oral or written testimony. CAS numbers are an easy and uncomplicated means of identifying chemicals. UFAC's search was hampered due to the lack of these numbers. Presumably CPSC's search also was hampered because the agency staff advised UFAC that they did not have the CAS numbers either. These should be provided to ensure that these chemicals are properly researched, and again, allow interested parties an appropriate review and comment period. Then parties will be able to meaningfully assess the adequacy of the SNUR process as outlined in the Chairman's letter.[39]

E. Decabromodiphenyl Oxide Follow-Up

Dr. Norris reviewed again the NTP study for decabromodiphenyl oxide at the request of Dr. Babich. Dr. Norris found that the acinar cell adenomas in the rats occurred in a significant positive trend and were mentioned in the abstract. The thyroid follicular cell adenomas or carcinomas were increased in the male mice in a dose-related pattern and also were mentioned in the study abstract[40].

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[38] Pease, *supra*, at p. 14.

[39] Chairman Brown's Letter, *supra*, at p. 2.

[40] NTP (National Toxicology Program), Toxicology and carcinogenesis studies of decabromodiphenyl oxide (CAS #1161-19-5) in F344 rats and B6C3F1 mice. 1986. [cited

While these neoplastic tumors do not meet the probability requirement for statistical significance ($p < 0.05$), occurrences of numerous different tumors suggest that this chemical may have a propensity for inducing adenomas and/or carcinomas. It would be Dr. Norris' recommendation that this be taken into account as the agency reevaluates this FR chemical for treatment of upholstered furniture fabrics.

IV. THE APPLICATION OF FLAME RETARDANT CHEMICALS

A. Inconsistency of Backcoating

Historically, backcoatings have been used to minimize ravel on the edges of cut fabrics, to improve seam slippage, to lock-in pile yarns in velvets, and to generally stabilize fabrics. To perform these functions, backcoatings can vary somewhat in thickness and application amounts. If backcoatings are required to control surface ignition, nearly perfect control of application amount and thickness will be required. Ms. Powell acknowledged that "there are many instances where there is not good control."[41] She is correct about the tremendous variation in the process application within a mill and from mill-to-mill and company-to-company.

There are no published test methods to evaluate and thus control the thickness of backcoatings. The thickness and amount of backcoating required is purely empirical. There are many factors dictating the amount of backcoating required, e.g., viscosity, latex type, amount of filler, amount and type of FR chemicals, the frothing process, dispensing of frothed latex, doctor blade type and setting, tenter frame speed, yarn type, fabric type and others. Controlling ravel and seam integrity is one thing, but control to guarantee small open flame ignition resistance is a far different - and more difficult - problem.

Inconsistency of application techniques for FR chemical backcoatings usually cannot be visually detected. It would only be glaring defects that could reasonably be expected to be detected by the inspectors. Technology may be available to produce proper materials, but there is no way to guarantee that yard after yard of

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in CPSC Briefing Package, 1997].

[41] Transcript of May 5, *supra,* at p. 274.

fabric being run through a tenter frame at 30/40 yards a minute will all end up with the same specific amount of FR backcoating front-to-back and side-to-side within a roll.

B. Exposure to Backcoating

The fabric samples with the non-FR backcoatings that Mr. Ziolkowski circulated are enclosed. They have been identified and marked.[42] Prints of the slides that were shown during Mr. Ziolkowski's oral testimony will be submitted under separate cover. They also will be identified and marked as the Commission requested.

Both the samples and the slides demonstrated that non-FR backcoatings can penetrate between the yarns and thus be present on or very near the face of the fabric, and FR backcoatings would perform in a similar manner. As Joe Ziolkowski pointed out, the term "backcoating" is an inapt description of the process. He cautioned that FR backcoating not be viewed as inclusion in a rubberized material such as a bath mat.

In the context of upholstery fabrics, particularly the lighter weight fabrics favored by most consumers, the backcoating may fill the interstices between the yarns and therefore become part of the substance and surface of the fabric. As Joe Ziolkowski noted in his presentation, the openness of the weave (interstices or spaces between the threads) is a basic feature of fabrics. It provides air flow and comfort. In other words, it allows the fabric to breathe. Without good air flow, the cushion would sit like a beach ball.

The slides that Joe Ziolkowski showed demonstrating the ability of the backcoating to rise to the surface of the fabric were taken from fabrics during actual production. The textile company that provided UFAC with these slides indicated that the fabrics shown in the slides encompass 75-80% of their product line. Further, the company said that the slide of the fabric that was not totally covered

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[42] Two packets of five fabric samples marked as (1) Control Original Fabric; (2) Backcoating Control; (3) Gray Backcoating; (4) Backcoating with Optical Brightener; and (5) Backcoating with sugar.

with the backcoating was typical of the foam application process, which is the most prevalent application method used for upholstery fabrics. There are other methods of backcoating, such as roller kiss-coating and spraying, but the frothed foaming process is the primary system utilized in the upholstery textile industry.

This textile company advised UFAC that there are three possible explanations for this deficiency: (1) the backcoating penetrated the textile more than in other areas; (2) there was a large bubble in the foam which prevented proper coverage; or (3) the uncoated area was simply missed or not "wet-out" by the foam and subsequent knife scraper.

If the foam backcoating has not fully dried before roll put-up, a "kiss-off" of the undried backcoating to the face of the fabric can occur. Further, backcoating "kiss-off" can occur in rolls of fabric in high temperatures, such as in trucks and non-air conditioned warehouses. When the backcoating kisses-off to the face of the fabric, it is immediately available for direct contact with consumers.

Inconsistency of backcoatings can be caused by trying to drive the backcoating further into the fabric or even having a batch of foam which has better wetting/soaking/penetrating properties. The further the backcoating is driven or penetrates into the fabric, the closer it comes to the face of the fabric. It is at the face of the fabric where chewing, sucking, and exposure to body fluids is most likely. Also, Mr. Ziolkowski reminded the Commission that arm caps can afford children another avenue of exposure, including direct skin or mouth exposure, to any FR backcoating.

C. Degradation of Backcoating

We have enclosed 18 cushion covers, marked and identified, that were returned to furniture manufacturers from consumers for a variety of problems. They all show differing levels of degradation of the backcoating. The cushion cover labeled Sample 8 was shown to the Commission at the hearing. All of the backcoating on this sample had disappeared and a question was asked as to its age. The furniture manufacturer advised UFAC that the fabric on this cushion cover was approximately twelve months old.

The disappearance of the backcoating is evidence of the degradation of the backcoating. Upholstery fabrics are not static. During use, upholstery fabrics move and stretch. Fabric movement over the stuffing materials causes abrasion. Abrasion causes backcoatings to wear off the back creating backcoating dust particles. Fabric movement also causes stretching. Stretching causes backcoatings to fatigue, crack, and tear. Stretching can cause backcoating particles to break away from the fabrics.

When upholstery fabrics are in use, backcoatings degrade because of tension, torsion, and shear forces. Tension forces come from the necessary over-stuffing of cushions and "pulling" the fabrics in place while stapling them to the frame. Tension forces also come from the act of sitting. The highest tension forces result from dropping one's body onto the cushion. For example, if a man weighing 200 pounds flopped into a seat from a height of one foot, he would exert 200 foot pounds of impact force on the seat. The largest tension force on a seat cushion is the impact force. However, quiet sitting can produce tension forces. Sitting also produces torsion forces in the cushion covers and shear forces are produced by squirming and changing seating positions. In addition, temperature and humidity affect the way that tension, torsion and shear degrade backcoatings.

To the best of UFAC's knowledge, there are no accepted standards, tests, or practices within either the textile or furniture industries that address the durability of backcoatings. This is true for both the U. S. and the United Kingdom.

When UFAC queried two British furniture manufacturing concerns (who wish to remain anonymous) about this issue, they also responded that they did not know of any test methods for backcoating durability. However, they acknowledged that they, like the rest of the furniture industry, had field problems with the breakdown of non-FR backcoatings prior to 1988. They said that present FR backcoatings do not perform any differently.

UFAC believes that the durability of backcoatings is related to the fabric type, yarn type, and fabric constructions. Inexpensive, lightweight fabrics with low pick and end counts show backcoating degradation quickly. These are the fabric types used on the lower priced furniture, the product generally used by households at the highest risk of residential fires. Thus, often those high risk households would not be given the protection they paid for and had a right to expect.

D. Significant New Use

Promulgation of a flammability performance standard for upholstered furniture that would have the practical effect of mandating the use of FR backcoatings on upholstery fabric was characterized by Mr. Kidder as merely an extension of existing FR uses into the residential environment.[43] In support of this statement, he cites to FR uses in transportation upholstery, California residential furniture, and commercial and institutional furniture among others. He likened FR residential upholstery fabric to these examples and denied that it would constitute a new use.

UFAC is aware that FR chemicals are used in some airplane upholstery and we are also aware that FR chemicals are used in some automotive upholstery. There are even some fabrics used for both applications which require no FR treatments to the fabric, e.g., some woolen fabrics and some fabrics made with FR yarns. Furthermore, the FAA and NHTSA standards are based on characteristics unique to travel.

The narrow range of designs and fabrics for seating in both aircraft and autos would not be accepted generally by consumers for use in their homes Further, FR chemical exposures from aircraft and auto seating are clearly limited by the duration of travel. In contrast, residential furniture has a continuing presence in the home over decades.

Oral and dermal exposures to infants, foreseeable in the home, are much less likely in aircraft and autos. While offgassing of flame retardants and other materials is known to occur in automobiles and aircraft, time-limited exposure and ventilation may minimize such FR chemical exposure.

It is misleading to suggest that FR chemicals are used widely in California residential furniture. Their use in applications in California is not analogous to what CPSC is considering. While FR chemicals are used in foams for California

[43] Transcript of May 5, *supra,* at p. 223.

residential furniture to comply with TB 117, they are not required for the residential upholstery fabrics. FR backcoating of the fabric along with FR foams is very rarely used for commercial and institutional furniture to meet TB 133.[44]

FR backcoating is not an extension of an existing use and to make such an argument is disingenuous. Consumers, both old and young, do not "live" with airplane or automotive upholstered seating in the same manner in which they "live" with upholstered furniture in their home environment. The degree of comfort, softness, and aesthetics for transportation fabrics is much less stringent than what consumers demand of residential upholstery fabrics.[45] A national mandatory flammability standard for residential furniture that necessitates the use of FR chemicals would have an unprecedented impact on the volume of these chemicals in the workplace, in the home and in the environment.

E. Technique for Backcoating

Another witness asserted that the techniques to apply these FR chemicals have been around "for a long time."[46] In support of this contention he pointed to the fact that FR chemicals are used in many applications and, thus, are not new technology. Comparing the use of FR chemicals in TV cabinets, automobiles, aircraft, and public occupancies furniture to residential upholstery fabrics is comparing, at the very least, apples to oranges. With respect to fabrics for furniture, this type of argument is specious because it refers to the FR technology to comply with TB 117 and TB 133 only. There is virtually no one in the U. S. who is FR coating or FR treating residential upholstery fabrics for use in the U. S.. FR backcoating of residential upholstery fabrics is a relatively recent technology.

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[44] The vast majority of furniture manufactured to TB 133 would fail the ignition test proposed by the CPSC because the most common approach to meeting TB 133 is the use of fire blocking barriers.

[45] UFAC contends that consumers leave their "easy chairs" in their homes feeling refreshed and relaxed. Air and auto travellers rarely comment on the comfort of their seating.

[46] Transcript of May 5, *supra*, at p. 238.

F. California Experience with FR Chemicals

UFAC has member companies that sell furniture in California. Furniture manufacturers do not use fire retardant chemicals to comply with the requirements of the fabric portion of California TB 117. California TB 117 does require foams to pass a vertical flame test. The foam suppliers handle the FR chemicals. When the furniture industry purchases foam, the foam manufacturer certifies that the foam meets TB No. 117's vertical burn test. At the present time, furniture manufacturers are not required to label their products for California Proposition No. 65. With the addition of some of these FR chemicals to the backcoating, it is anticipated that labeling will likely be required.

G. United States Experience with BS-5852

A small number of UFAC's member companies are shipping furniture into the United Kingdom which complies with the British standard. Compliance is predominantly accomplished by the use of interliners rather than FR backcoatings of fabric.

However, UFAC is aware of the fact that some U. S. fabrics are being sent to the United Kingdom for FR backcoating. These companies advised UFAC that the available fabrics are very limited and are generally drawn from the middle to high end of their lines. The textile mills are not offering their complete line of fabrics because of their experience that many of their fabrics are not able to be FR chemically treated to pass the requirements of BS 5852 and still maintain the aesthetics demanded by the consumer.

H. Availability of Fabrics

A question was asked as to what fabrics would be lost to upholstery manufacturers if they had to backcoat the materials with FR chemicals in order to meet the CPSC's draft test method. UFAC believes that silk fabrics[47], double-cloth

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[47] While the Keyser Ciprus study indicates that silk constituted .04% of the residential upholstery market (or 147,200 linear yards) in 1997, that translates into approximately 29,440 chairs (assuming five yards of silk per chair) a year made with silk that will disappear from the market

woven jacquards, some velvets, chenille fabrics, fabrics with a high degree of face floats, matelassé fabrics, other complex structure type fabrics[48] and some polished and lightweight cotton fabrics cannot be made to pass the proposed ignition standard. The major reason these fabric types will be lost is that processes and materials have not been developed to backcoat these fabric types adequately to pass the United Kingdom or the proposed CPSC ignition tests.

The United Kingdom authorities have evidently recognized the inherent technical problems associated with FR backcoating many of these materials. Consequently, the British standard allows those fabrics containing 75% or more rayon, linen, silk, or flax and cotton to use a barrier/fire blocker underneath these fabrics in lieu of a FR backcoating in order to comply. The British furniture manufacturers to whom UFAC has spoken indicated that they knew of no one who was using silk that had been FR treated. UFAC was advised that, in the United Kingdom, 100% polished cottons and other lightweight 100% cotton fabrics are treated with Pyrovatex®.[49]

The real problem in determining which fabrics will be lost is that the fabric construction for aesthetics and styling purposes is a continually moving target changing several times each year. As a result, every new fabric construction concept will have to be thoroughly tested. The lead time between showing furniture at markets and shipping that furniture often consumes several months or more.

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[48] For example, some Haitian cotton fabrics and woven fabrics with large accent yarns in variable areas on the face of the fabric.

[49] Ciba met with Margaret Nealy and other CPSC staff in regard to the problems associated with Pyrovatex® for use in children's sleepwear. They highlighted an array of problems associated with it in regard to the quality and consistency of the application process. There were problems associated with laundering, particularly with acid sour rinses. Ciba recommended against using Pyrovatex® for children's sleepwear.

Furthermore, research on Pyrovatex® shows that it can decompose when exposed to moisture, particularly moisture which is acidic. Based on this, UFAC can predict that storage stability of upholstery fabric treated with Pyrovatex® will be a problem. Rolls of fabric are shipped in some type of wrapping, usually polyethylene film. In the back of a truck in warm, humid weather, some decomposition can be triggered. The same thing can happen when wrapped fabric is stored in a manufacturer's non-climate controlled warehouse.

Adding additional time for testing and fabric production will add even more time to this production and distribution process.

What has been described are all real problems. They are not related to the ingenuity of the American textile industry. The textile industry in the U. S. is one of the most innovative and ingenious in the world. According to the Keyser Ciprus Limited Study, in 1997 there was 403,250,400 linear yards of upholstery fabric manufactured for the residential market in the United States. That makes the U. S. residential upholstery market 575% larger than the United Kingdom market.

At the present, non-FR backcoating of cover fabrics is characterized by problems with wrinkles, puckers, "hand" and "breathability".[50] Certainly, more problems will be created with the addition of FR chemicals to the backcoating. Ironically, for the past ten to fifteen years, the styling trends in the U. S. have been toward treatments, such as washing, heating and warm tumbling, to produce ever softer, more luxurious feeling fabrics. As a matter of fact, with the entire U.S. furniture industry striving for softer and more supple fabrics, the textile industry is continually attempting to use less and less backcoating. It is not likely that FR backcoating will provide the aesthetics, hand, air permeability and feel demanded by the American buying public.

We cannot look to the United Kingdom experience (with different fabric choices and optional FR treatments) and transfer that experience to this country. For example, one of the witnesses asserted that polypropylene fabrics were on their way out in the United Kingdom so the loss of this fabric, due to backcoating problems, was not significant.[51] However, the Keyser Ciprus Limited study shows that 100% polypropylene fabrics account for 12% of the U. S. upholstery fabric market. Polypropylene yarns of various types are also used in blends, but there is no way to quantify how much except to say that polypropylene yarns are very important in the U. S. market. Polypropylene fabrics are usually "low end" fabrics and increases in price or elimination of them as a fabric group will adversely affect the price of lower cost furniture which the lower social economic groups purchase.

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[50] H. Fincher, Rigors of Compliance with the British Flammability Standard, AFMA Flammability Seminar, March 28, 1995.

[51] Transcript of May 6, *supra,* at p. 110.

A CPSC official has acknowledged this phenomena as a potential downside to small open-flame regulation.[52] He noted that the agency's 20 second flame test was selected to virtually require FR treatment or interliners and, thereby, provide an incentive for manufacturers to retain thermoplastic fabrics in their lines.[53] Once again, it is noteworthy that interliners would not, by themselves, yield compliance with the proposed test method. It is clear that a performance standard designed to simulate real world small-open flame scenarios should not be made more or less stringent on the basis of non-statutory criteria.

The loss of a wide array of fabrics has clearly been the case in Britain, even though BS-5852 provides an exemption for cellulosics placed over fire-blocking interliners (no such provision is made in the draft US regulation). The editor of the United Kingdom trade publication *Cabinet Maker* previewed the fabrics at a 1996 Italian trade show and noted that most would be lost to the United Kingdom market.

> *The fabrics on display were as beautiful as the setting. But it makes me sad to think that so few of these exquisite weaves and prints will ever reach the United Kingdom market, mainly because of our stringent fire retardance regulations. A number of mills commented that although they would like to export more to the United Kingdom, the application of FR backings would ruin the special feel and texture of the fabric, and the add-on cost of using lining would raise the end price out of all proportion.*[54]

V. CONCLUSION

UFAC remains greatly concerned with the lack of exposure and bioavailability toxicity data on the FR chemicals that CPSC staff identified as being suitable for upholstery application. The lack of durability of the FR backcoating may create exposure problems that have not been considered by the CPSC staff.

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[52] Dale R. Ray, Presentation to SPI, July 8, 1997.

[53] D. Ray, CPSC Staff Briefing on Upholstered Furniture Flammability Projects, December 18, 1997.

[54] Felicity Murray, *Cabinet Maker*, May 1996.

Further, UFAC is concerned with the lack of definition as to whether CPSC or EPA will have the regulatory responsibility for evaluating the toxicological data on these chemicals and what criteria they will apply to their risk assessment. Finally, the supporting toxicological data for the 24 FR chemicals that FRCA identified as suitable for use on upholstery have not been made part of the public record of this proceeding and consequently have not been subject to meaningful review and comment.

UFAC appreciates the impetus to move forward with dispatch to reduce the incidence of residential fires. UFAC was formed for this purpose and is credited for achieving a great deal on this front. At the same time it is imperative that our decisions be not only efficient but wise, and that they recognize when more information is needed. In his written submission, Dr. Gary Stevens observed:

> *...[t]he human and environmental toxicology of flame retardants, in common with other chemicals, is incomplete and no conprehensive life-cycle benefit studies have been performed to date. It is important that each flame retardant is considered in the context of its incorporation into consumer products and that its human exposure and environmental lifecycle risks are assessed.*
>
> *It is not possible currently to complete the risk-balance equation for long term effects... Our level of confidence is limited because of incomplete information on the long term human exposure toxicology and environmental impact of flame retarded products and the lack of any lifecycle risk assessment experience in this field We would recommend that these areas continue to receive attention as part of the ongoing programme on assessing existing substances in Europe and where possible the activity should be accelerated for the more commonly used flame retardants in consumer products.*[55]

Because of this incomplete informational framework and the immense public health and safety ramifications of the CPSC staff proposed test method, UFAC respectfully recommends that the Commission proceed cautiously and deliberatively to address these concerns.

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[55] G. Stevens, *supra*, at p. 25.

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PHONE (901) 274-9030

August 3, 1998

Ms. Rockelle Hammond
Office of the Secretary
US Consumer Product Safety Commission
Washington, DC 20207

Re: *Flame Retardant Chemicals* -- Post Hearing Comments of the National Cotton Batting Institute

Dear Ms. Hammond:

These post-hearing comments are submitted by the National Cotton Batting Institute (NCBI) in response to CPSC's April 14, 1998 notice of extension of comment period and request for comments on flame retardant chemicals that may be suitable for use in upholstered furniture (63FR18183). NCBI is the central organization that represents the fiber batting industry and is affiliated with the National Cotton Council, whose members represent 75% of the U.S. cotton and cotton processing industries.

As part of CPSC's review of the toxicity of flame retardant chemicals, NCBI is providing this information on the safety of boric acid as a flame retardant for cotton batting and in compacted cotton batts used as barriers and interliners. Boric acid when applied correctly to cotton batting provides both cigarette ignition resistance and open-flame resistance. NCBI endorses the detailed comments submitted by U.S Borax (part of the Fire Retardant Chemicals Association comments) and the findings of the National Toxicology Program (Technical Report Series No. 324, "Toxicology and Carcinogenesis Studies of Boric Acid in B6C3F1 Mice," U.S. Dept. HHS, PHS, NIH, Oct. 1987) regarding the toxicity of boric acid. NCBI is including a copy of its Quality Assurance program and additional supplemental information from U.S. Borax and the NTP abstract (NTP TR 324) to document the safety and reliability of boric acid. NCBI also has a videotape available which demonstrates how treated cotton batting performs, and the proper way for boric acid to be applied to cotton batting in the manufacturing process. The net 10% boric acid used in Fire Retardant cotton batting is an odorless, powdered substance that is not flammable, combustible or explosive. It presents no unusual hazard if involved in a fire. The particles of the powdered boric acid are much smaller than the diameter of a mature cotton fiber. This fact allows a uniform coverage of the boric acid onto the individual cotton fibers. 10% boric acid in FR cotton batting does not present a hazard to human beings when used in occupational or home-use settings and there is no exposure to boric acid from the treated cotton batting. Diluted boric acid is sold over the counter in drugstores for use in eye wash. The material safety data sheet for common table salt is very similar to the MSDS for boric acid.

One of our organization's major accomplishments in the past decade has been its Quality Assurance Program, which was launched in 1993. The program is the result of a joint effort between NCBI and the

Upholstered Furniture Action Council (UFAC) to develop guidelines whereby manufacturers can do the best job possible in producing a consistent and quality-designed cotton batting product for end-users. *The cornerstone of the program is an approved standard test method for application of boric acid during the manufacturing process for smolder resistant/fire retardant cotton batting.* The program has been widely acclaimed for its effectiveness. It is a prime example of the cotton batting industry trying to make sure that its customers receive a quality product.

At the heart of this program is the reliability of boric acid and the way it performs. We agree with the most recent toxicology studies conducted on the safety of boric acid as a fire retardant on cotton batting -- particularly when used on filling materials in mattress and upholstered furniture. Many studies and tests have been conducted on the safety of boric acid and the conclusions are all consistent. It is a benign chemical which doesn't present harm or potentially dangerous threats to human beings who come in contact with it every day.

Scientific studies continue to prove that boric acid is a safe product and poses no threat to the general public. Of even more importance in this discussion is the fact that NCBI is currently strengthening its Quality Assurance Program by exploring the possibility of a mandatory inspection of cotton batting manufacturers to guarantee that boric acid is applied properly and meets the minimum standards of the program's requirements for application of the fire retardant. It stands to reason that NCBI wouldn't have launched its 1993 Quality Assurance Program if there had been any question about the safety and reliability of boric acid as a fire retardant. It also is important to note that the strengthening of this program now wouldn't be proceeding if boric acid weren't safe and reliable.

In summary, our organization endorses the findings of U.S. Borax whose comments are included in the package of information submitted by the Fire Retardant Chemicals Association (FRCA). NCBI believes that properly treated cotton batting performs in exceptional fashion to prevent both cigarette and open-flame ignition. It is because of this consistent performance of boric acid as a flame retardant that NCBI hopes to launch its mandatory testing to ensure that all of its members are complying with the organization's Quality Assurance Program and that we can share this information with other affiliated industries who have an interest in this issue. When one considers that boric acid is used in our everyday lives in such products as table salt and eyewash, it is hard to understand how it could be categorized as hazardous to human beings as a fire retardant on filling material in upholstered furniture or mattresses.

We look forward to working with CPSC and appreciate its consideration of these comments. Please contact me if you have questions or additional information is needed.

Sincerely,

Tommy Horton

Tommy Horton
Executive Secretary
National Cotton Batting Institute

Attachments

NTP TECHNICAL REPORT

ON THE

TOXICOLOGY AND CARCINOGENESIS STUDIES OF BORIC ACID

(CAS NO. 10043-35-3)

IN B6C3F1 MICE

(FEED STUDIES)

NATIONAL TOXICOLOGY PROGRAM
P.O. Box 12233
Research Triangle Park, NC 27709

October 1987

NTP TR 324

NIH Publication No. 88-2580

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
National Institutes of Health

$B(OH)_3$

BORIC ACID

CAS No. 10043-35-3

H_3BO_3 Molecular weight 61.83

Synonyms: orthoboric acid; boracic acid

ABSTRACT

Boric acid is a component of cosmetics and pharmaceuticals and is also used in numerous industrial processes. Earlier long-term studies did not demonstrate a carcinogenic effect in Sprague-Dawley rats (Weir and Fisher, 1972). Because of potential widespread human exposure, corroborative evidence was sought in a second species. Toxicology and carcinogenesis studies were conducted by feeding technical-grade boric acid (99.7% pure) to groups of male and female B6C3F$_1$ mice for 14 days, 13 weeks, and 2 years.

In the 14-day studies (five mice per group), mortality occurred in mice fed 25,000 ppm, 50,000 ppm, or 100,000 ppm boric acid; hyperplasia and/or dysplasia of the forestomach was also seen in these dose groups. No compound-related gross pathologic or histopathologic effects were seen in male or female mice exposed at concentrations up to 12,500 ppm in feed. In the 13-week studies, groups of 10 male and 10 female mice were fed boric acid at concentrations up to 20,000 ppm; 8 male mice and 1 female mouse receiving 20,000 ppm and 1 male receiving 10,000 ppm boric acid died before the end of the studies. Male and female mice receiving 20,000 ppm boric acid weighed 23% and 18% less, respectively, than did the controls at the end of the studies. Testicular atrophy in 8/10 male mice, hyperkeratosis and acanthosis of the stomach in 8/10 male and 3/9 female mice, and extramedullary hematopoiesis of the spleen in all male and female mice receiving 20,000 ppm boric acid indicated that the testis, stomach, and spleen were potential target organs in the 2-year studies. Based on these results, 2-year toxicology and carcinogenesis studies were conducted by feeding diets containing boric acid at concentrations of 0, 2,500, or 5,000 ppm to groups of 50 male and 50 female mice.

Survival of high dose male mice after week 63 and of low dose male mice after week 84 was lower than that of controls (final survival: control, 41; low dose, 30; high dose, 22), which may have reduced the sensitivity of the carcinogenicity study; the numbers of female mice (33; 33; 37) that survived to the end of the studies were considered adequate for toxicologic evaluation. Body weight gain was reduced in each sex after week 30; mean final body weights were 7% and 13% below control values for exposed male mice and 7% and 20% below those of controls for exposed female mice. No chemically related clinical signs were reported.

At the top dose, boric acid caused an increased incidence of testicular atrophy (control, 3/49; low dose, 6/50; high dose, 27/47) and interstitial cell hyperplasia (0/49; 0/50; 7/47) in male mice. The testicular atrophy was characterized by variable loss of spermatogonia, primary and secondary spermatocytes, spermatids, and spermatozoa from the seminiferous tubules. The seminiferous tubules contained primarily Sertoli cells and variable numbers of spermatogonia. In some mice, there were accumulations of interstitial cells, indicating hyperplasia.

In low dose male mice, there were increased incidences of hepatocellular carcinomas (5/50; 12/50; 8/49) and hepatocellular adenomas or carcinomas (combined) (14/50; 19/50; 15/49) and an increased incidence of subcutaneous tissue fibromas, sarcomas, fibrosarcomas, or neurofibrosarcomas (combined) (2/50; 10/50; 2/50). No increased incidence of subcutaneous tissue neoplasms was seen in male mice receiving 5,000 ppm. Because the incidence of subcutaneous tissue tumors is variable in historical controls, because there was no corresponding increase in the high dose male mice, and because the incidence of hepatocellular tumors was not significant by the incidental tumor test and was within the historical control range, neither of these tumors was considered to be related to the administration of boric acid.

Boric acid was not mutagenic in the Salmonella/microsome assay with *Salmonella typhimurium* strains TA98, TA100, TA1535, or TA1537. Boric acid was negative in the mouse lymphoma L5178Y/TK$^{+/-}$ assay and did not induce sister-chromatid exchanges or chromosomal aberrations in Chinese hamster ovary cells. All assays were performed with and without metabolic activation.

The data, documents, and pathology materials from the 2-year studies of boric acid were audited at the NTP Archives. The audit findings show that the conduct of the studies is documented adequately and support the data and results given in this Technical Report.

Under the conditions of these 2-year feed studies, there was *no evidence of carcinogenicity** of boric acid at doses of 2,500 or 5,000 ppm for male or female B6C3F$_1$ mice. Testicular atrophy and interstitial cell hyperplasia were observed in high dose male mice. The decrease in survival of dosed male mice may have reduced the sensitivity of this study.

*Categories of evidence of carcinogenicity are defined in the Note to the Reader on page 2.

A summary of the Peer Review comments and the public discussion on this Technical Report appears on page 8.

the nineteenth exposure day at the nominal concentration of 12.8 ppm as BF_3. Deaths still occurred in guinea pigs, but not in rats, exposed at an analyzed concentration of 3 to 4 ppm, but all three species exposed at an analyzed concentration of 1.5 ppm were only minimally affected, with average body weights of the guinea pigs only 85 percent of that of controls, and showing only occasional pneumonitis. Rabbits did not differ histologically from controls. Fluorosis of rat teeth was observed at the highest dose. A TLV of 0.3 ppm was recommended, which is below the 1.5 ppm olfactory detection limit (79).

8 INDUSTRIAL HYGIENE ASPECTS OF BORON AND INORGANIC COMPOUNDS

8.1 Introduction

Earlier in this chapter it was shown that nearly 338,000 metric tons of boron minerals and compounds (expressed as B_2O_3) were consumed in the United States alone, and the major end uses were documented. Compounds of boron are obviously very useful, and consequently the potential for occupational exposure to these compounds is appreciable and widespread. Although a substantial number of compounds are described in the early parts of this chapter, it is significant that the so-called Group 1 compounds (Table 42.3) account for most of the boron compounds used in commerce. One estimate made in relation to Table 42.3 is that the general class of inorganic borates that comprises this group represents over 98 percent of the total tonnage recorded. It is probable that most persons have used or encountered some of these compounds for one of several purposes in their lifetimes.

Inorganic borates have never presented the industrial hygienist with difficult or unusual problems, although it is true, of course, that in the producing plants engineering controls may be expensive and challenging. Because the borates are of acknowledged low toxicity, are not corrosive, and do not possess other properties that could make control difficult, both the measurement of borate dust levels and their subsequent control have required only the good judgment of the industrial hygienist and the skills of the engineers.

Because of the substantial number of workers who are exposed to borate compounds during their production and subsequent usage, one of the major producers undertook a study to determine whether respiratory irritation was a significant problem, as had been indicated earlier by a group of investigators headed by Garabrant (75). The results of the new study are described in some detail above (74). A unique aspect of the study, and one that had never before been part of a major study of borate compounds, was the collection and analysis of a large number of air samples during normal work operations. In the earlier Garabrant study of irritant effects, no air samples were taken for comparison with reported symptoms, and only air sample results from earlier surveys were available. The Wegman et al. study is the largest examination of inorganic borates in the workplace ever performed, and its findings and recommendations concerning air sampling methodologies and logical occupational exposure levels (OELs) justify more extensive coverage in this section than might normally be accorded such a study.

8.2 Borate Irritant Effects Study

As has been noted earlier, the health outcomes of the study were limited to the extent of irritation experienced by workers at dust levels that prevailed in the plants. Because of the study requirements, principally in relation to the correlation of concentrations of dust and the perception of irritation, an otherwise relatively simple study became much more complex. Prior to beginning the study, for example, there was widespread belief that irritation was best related to short-term exposures to relatively high concentrations of dust, thereby making it imperative to make "real time" measurements of the levels to which workers were exposed. At the time the study was planned, there was no practical means of collecting the several thousand short-term samples required, and a considerable amount of the research was dedicated to defining a means of measuring dusts which would be suitable for short-term samples. The investigators were successful in doing so, with the result that the findings of the study are believed to be unique in the practical world of industrial hygiene dust measurements. The method selected and tested has been described (78). The study protocol required that the dust levels be monitored continuously by a direct-reading device, the output of which could be interpreted to yield the total dust level over any short-term period selected. The device selected was a commercially available instrument known as the Miniram, a light-scattering device that could hardly have been predicted to have performed so well; it was originally designed to collect particles in the respirable range. It is very dependent upon accurate calibration and upon the assumptions that the material used for the calibrations is the same as the material being measured. Anyone interested in using the Miniram for routine monitoring should consult the paper by Woskie et al. (78).

Traditionally borate dusts have been measured in a simple manner by drawing air through a filter according to an accepted protocol, and determining the amount of material collected. It was rarely felt necessary to determine the boron content of dust collected in an environment of almost pure borate dust. In the Wegman et al. study it was decided to analyze for boron as well as to make gravimetric determinations of the dust (74).

8.2.1 Air Sampling for Borate Species

The study concluded, based on a large volume of data, that the material collected on a filter becomes different from the material originally dispersed, perhaps immediately. In any event, at the conclusion of sampling, it is very unlikely that a calculation of the percent boron in the sample will confirm that a particular species was indeed sampled. It became apparent that temperature and moisture conditions in the sampled air were complicating factors that could not readily be corrected. In other words, the study suggested that sampling performed in a hot, damp climate, such as southern Texas or Louisiana in summer, for example, would probably be considerably different from samples collected in a relatively cool, dry climate.

If these conclusions are to be believed, and the investigators felt that they should be, then there is no need to establish different TLVs or standards for separate borate salts that differ only in the extent of hydration. The conclusion is supported by the finding that exposures to dusts that were believed to consist of anhydrous pentahydrate or decahydrate borate particles did not result in significant differences in the degree of irritation experienced by the subjects studied.

8.2.2 *Criteria for Borax TLVs or PELs*

In establishing TLVs or permissible exposure limits (PELs) for any substances, it is necessary to make certain decisions, based upon the properties of the materials being considered. In the case of borax compounds, these decisions included (1) the necessity for a short-term exposure limit of some kind; (2) the necessity of determining boron, rather than measuring total weight; and (3) a decision concerning whether the best index of exposure is total dust, the respirable fraction, or some other fraction of the dust.

8.2.2.1 Short-Term Exposure Limits. The Wegman et al. study (74) addressed these problems, and satisfactorily resolved them. Thus, regarding the need for some sort of a short-term exposure limit, one of the options was the designation of the compounds as sufficiently irritating to require a "C" designation. The data clearly ruled out any need for such a designation, which, by definition, does not permit even modest variations above the threshold limit value (TLV).

In regard to establishing a short-term exposure limit (STEL) as defined by the American Conference of Governmental Industrial Hygienists (ACGIH) TLV Committee (80), there was nothing in the study results that indicated any need or any basis for establishing a STEL. It was ultimately recommended that the optimal TLV or PEL should be a traditional full-shift TWA measurement even though a slightly steeper slope to the dose response curve was seen when 15-min increments of exposure rather than full shift were used.

8.2.3 *Analysis of Samples for Boron Content*

Regarding the need for boron analyses, the study concluded that under most circumstances it is satisfactory to rely on the total weight of material collected as an index of exposure. The study results showed a high degree of correlation between measured concentrations expressed as total dust, and concentrations expressed as milligrams of boron per cubic meter of air. Thus, when sampling within a borate-producing plant, where it is virtually always certain that the only airborne dust is from one or more of the borate compounds, nothing is gained by performing a boron analysis.

In another setting, where borate dusts might be mixed with dusts from other materials, it is obvious that total weight would not accurately represent the amount of borate dust in the air. If the other dust or dusts are not known to be toxic, and are generally controlled by a total dust measurement, then the measurement of the dust mixture is probably a satisfactory basis for controlling employee exposures. In the event that some other material substantially more toxic than borates is mixed with the dust, then of course it would become necessary to make a determination of this substance as a separate matter. Even in such an instance, if the total dust level were less than 10 mg/m^3, it is likely that adequate controls for borate dusts are in place.

If for some reason there is a need to determine the boron content of the dusts sampled, then any of several methods discussed earlier in this chapter are satisfactory. Several of these methods have the required sensitivity and accuracy to permit analysis of the small amounts of boron likely to be present on an average filter.

8.2.3.1 Fraction of Dust to be Sampled. If the fraction of the dust to be sampled is limited to traditional choices, that is, total dust, or the respirable fraction, the choice is simple: total dust has always been measured, and continues to be the method of choice. Borates are water soluble, and the few particles likely to reach the deep lung because of the large particle size of these dusts will be quickly absorbed into the systemic circulation. Thus, measurements of the respirable fractions are unsuitable. Current developments, however, have complicated what was previously a simple decision.

8.3 Current Developments in Aerosol Sampling

The standard method used in the United States, still required to be used in connection with efforts to determine whether a plant is in compliance with an Occupational Safety and Health Administration (OSHA) or Mine Safety and Health Administration (MSHA) standard, is the simple total dust method, which is basically the same no matter what total dust is being sampled. Standard closed-face cassettes are generally used and each of the cited methods gives the required details concerning how to perform this relatively simple measurement.

As a result of international deliberations for some years, in 1985 the ACGIH published a monograph entitled "Particle Size Selective Sampling in the Workplace" (81). This monograph describes in detail the need for changed criteria, and although the details are beyond the scope of this chapter, the recommendations made are the same as those now contained in the TLV booklet and can be summarized as follows.

In Appendix D of the 1992–1993 TLV booklet (80), a brief preamble describes the need for what are called particle-size selective TLVs (PSS-TLVs). Three fractions are described. The first is called inspirable particulate mass TLVs, abbreviated IPM-TLVs, and is applicable when materials that are hazardous when deposited anywhere in the respiratory tract are encountered. The next fraction is called thoracic particulate mass TLVs (TPM-TLVs), and applies to those materials that are hazardous when deposited anywhere within the lung airways and the gas exchange region. The third fraction is called the respirable particulate mass TLVs

(RPM-TLVs) and is used for those materials that are hazardous when deposited in the gas exchange region.

In the case of borates where effect is on airway or other mucous membrane surfaces or is a result of absorption through them, it is a simple matter to rule out the need for either the thoracic TLVs or the respirable fraction; clearly then, the appropriate measurement to be made is the inspirable particulate mass.

The inspirable particulate mass is similar to, but not identical to, the total dust measurements that have always been made, and in fact must still be made in the United States when compliance with OSHA standards is at issue. The sampling characteristics of the recommended sampling heads for inspirable mass are not the same as those for traditional total dust measurements, and reference is made earlier in this chapter to a boron absorption study, which in fact compared results obtained by both methods. It should be emphasized that the ACGIH TLV Committee has not yet classified the dusts and other particulate substances on its list according to these three proposed classes, but can be expected to do so eventually. It is probably correct, therefore, to make the recommendation that for simple sampling related to compliance, the recommended method is the standard total dust method that has always been used in the United States. On the other hand, if an epidemiologic study is planned that requires the best measurement of the dust to which workers are exposed, then it becomes necessary to decide whether the inspirable mass should be sampled or total dust as previously defined, or a combination of the two. The absorption study of Culver et al. (43) did both, and concluded that the results using the inspirable sampling head were better able to predict absorbed dose of borate as measured by blood and urine concentrations than were results from the traditional total dust sampling procedure.

8.4 TLVs and PELs—Historical

The dual TLVs of 1 and 5 mg/m^3 that were placed on the TLV list notice of intended changes in 1975 have remained on the 1992–1993 list, even though there has been reason to believe that the TLV Committee was planning to change its TLV and documentation based on the findings of the borate dust study.

Similarly OSHA in adopting the 1968 TLV List in 1970 (9), did not have on the original Z-1 list a TLV of any kind for sodium tetraborate salts. In the PEL program completed under the administration of Assistant Secretary of Labor for OSHA, John Pendergrass, the PEL for sodium tetraborate was included and the value selected was 10 mg/m^3 (10). On March 22, 1993, however, a court ruling had the effect of annulling the changes made in the PEL project; hence the PELs presently in effect, with few exceptions, are still those of the 1968 TLV List. Consistent with that change, of course, there is presently no sodium tetraborate-specific OSHA PEL and the "nuisance dust" OSHA PEL or the 10-mg total dust ACGIH TLV may be the controlling factor for worker protection. However a standard based on insoluble dusts should not be applied to soluble dusts such as the borates where the mechanism of action, if any, will be at the systemic level.

The MSHA, by contrast, has for some time been guided by a PEL of 10 mg/m^3

for all forms of sodium tetraborate salts, and still uses this value in making its field evaluations. It is highly desirable and probable that eventually the ACGIH TLV Committee, OSHA, and MSHA will agree on the same value, but for other than scientific reasons this may not occur quickly.

8.5 Standards in Other Countries

Australia and the United Kingdom both chose to adopt the ACGIH recommended TLVs of 1 mg/m^3 for anhydrous and pentahydrate salts, and 5 mg/m^3 for the decahydrate. Australia adopted these values in 1990 and the United Kingdom adopted them in 1991.

One other country, Sweden, is known to have adopted standards for exposure to the decahydrate of 2 mg/m^3, short-term (15 min) value of 5 mg/m^3, together with the notation "skin" in 1984.

Australia adopted a standard of 10 mg/m^3 for boron oxide in 1990. The Federal Republic of Germany adopted a two-part standard in 1990 as follows: total dust 15 mg/m^3, short-term level 75 mg/m^3, 30-min periods, twice per shift. The United Kingdom established in 1991 a standard of 10 mg/m^3, with a 10-min STEL of 20 mg/m^3 (82).

8.6 Boron Oxide and Boric Acid

The 1992–1993 TLV List lists boron oxide with a TLV of 10 mg/m^3. Presumably this substance is similar to boric acid, and the TLV for boric acid may be assumed to be 10 mg/m^3 also. So far as is known, there are no differences in approaches to sampling and analyzing boric acid than for the borates.

8.7 Industrial Hygiene Control Procedures

The control of dust exposures in the borate-producing industry is a straightforward industrial hygiene proposition where all of the classical industrial hygiene control methods with the exception of substitution are routinely used. The greatest opportunities for exposure to significant dust levels arise after the material has been made and dried and must next be packaged or transferred to a suitable container for transporting quantities of bulk materials. Much of the finished material goes out in paper bags, and large quantities also are shipped by truck or by rail. No matter how it is prepared for shipment, the dust emitted can be controlled by standardized enclosures and local exhaust ventilation.

Although respiratory protection is available that will readily remove borate dusts to the extent required, the use of respiratory protection as a routine control measure is not recommended. Certain short-term high-exposure situations can arise, however, making the use of a respirator the only feasible method of controlling exposures, and temporary problems arising from equipment failure or lack of some required equipment can also lead to the use of respiratory protection for a fixed period of time. The same considerations apply to potential exposures in plants where borate compounds are used, and are subject to control by the same methods used in the producing plants. Whenever respiratory protection must be used, compliance with OSHA or MSHA requirements is required.

8.8 Other Boron Compounds

As noted earlier, there are other boron compounds that are produced and used in relatively small quantities, some of which are highly toxic and hazardous. The principal classes of such compounds are the boron halides and the boron hydrides or boranes, as they are generally named.

8.8.1 Boron Trihalides

The principal members of this group of compounds are boron trifluoride and boron trichloride. Boron tribromide is used to a lesser extent.

8.8.1.1 Boron Trifluoride. The TLV for boron trifluoride was first set at 1 ppm as a TWA by the ACGIH in 1962. In 1963 the "C," or ceiling notation, was added in accordance with committee policy to so designate strong irritants. The TLV remains 1 ppm C on the 1992–1993 TLV list (80). The OSHA PEL is also 1 ppm, ceiling. The National Institute for Occupational Safety and Health (NIOSH) agreed with OSHA, and in addition recommended an immediate danger to life or health (IDLH) value of 100 ppm. Several other counties have also established standards for BF_3, specifically Australia—1 ppm peak limitation in 1990; Federal Republic of Germany—1 ppm, short-term level; 2 ppm for 5-min periods, eight times per shift, in 1990; and United Kingdom—1 ppm, 10-min STEL—1 ppm, in 1991 (83).

Stokinger (61) discussed several sampling and analytic methods used for determining atmospheric BF_3 levels, but found difficulties with all of them.

The 1976 Criteria Document (84) on BF_3 made a thorough review of all sampling and analytic methods known, but was unable to recommend a single method, and noted that none had been validated to the degree required.

OSHA (86) recommends a method developed at its Salt Lake City Laboratory which requires sampling in a midget fritted glass bubbler containing 10 ml of 0.1 *N* NH_4F. and determination with an ion-specific electrode. The ion actually determined is fluoroborate ion, (BF_4^-).

OSHA also notes that an infrared unit, (Miniram) may be used, with a minimum detection of 1.0 ppm at 7.4 μm.

Rusch et al. (85) performed extensive inhalation toxicity studies with BF_3. Frequent analyses of chamber concentrations were made by collecting samples in midget impingers (presumably containing distilled water, but not stated by author) or on membrane filters. BF_3 content was determined by an ion-selective electrode technique. Although the TLV does not include a "skin" notation, it is noteworthy that higher concentrations are likely to fume in moist air, and are corrosive to the skin. Measures to prevent skin exposure as well as inhalation exposure are therefore required.

8.8.1.2 Boron Trichloride. Stokinger (61) noted that no TLV had been established for boron trichloride more than 10 years ago, and no value is listed in the 1992–1993 TLV list. Stokinger also expressed the opinion that because the material was more corrosive than boron trifluoride, the TLV should be lower than 1 ppm. The literature does not include a sampling and analytic method for boron trichloride, nor does OSHA or NIOSH offer a method, but presumably samples, if collected properly, could be analyzed for boron content by several methods previously described.

8.8.1.3 Boron Tribromide. Boron tribromide also has a TLV of 1 ppm, originally proposed in 1967 as a TWA, then modified in 1984 to become 1 ppm C.

Stokinger (61) expressed concern more than a dozen years ago that the TLV was based on the decomposition of BBr_3 to 3 mols of HBr but neglected the possibility of independent toxicity of BBr_3 itself. He concluded, therefore, that the TLV of 1 ppm may not be sufficiently conservative.

The OSHA PEL is also 1 ppm ceiling. Standards in other countries include Australia—1 ppm peak limitation (1990) and United Kingdom—10-min STEL 3 ppm (1991) (88).

The OSHA Salt Lake City Laboratory method for BBr_3 (86) requires collection in a midget fritted glass bubbler containing 10 ml 0.003 *M* $NaHCO_3$/0.0024 *M* Na_2CO_3. The analysis is performed by ion chromatography, based on hydrolysis of the sample to form bromide ion. A specific OSHA method (ID-108) is recommended for the analysis.

BBr_3 apparently behaves in a manner similar to BF_3 and BCl_3, so skin protection is also recommended when using high concentrations of the substance. Stokinger recommends that personnel handling or exposed to BBr_3 should wear eye, face, hand, and body protection and the compound should be used under a hood with adequate ventilation. He further recommends that an air-supplied respirator or oxygen-supplied mask, as well as a chemical shower, should also be readily available. Additional emergency measures to be taken in the event of skin or eye contact are also outlined.

9 PHYSIOLOGICAL AND TOXICOLOGIC EFFECTS OF THE BORON HYDRIDES

The boron hydrides, diborane, a gas, pentaborane, a liquid, and decaborane, a solid, although first described in 1879 (90) were not widely explored until the 1950s when they underwent extensive evaluation as potential rocket fuels. Their composition of only the lightweight elements hydrogen and boron gave them theoretically high propulsion characteristics. However, their performance was disappointing. Despite this, the interest stimulated pharmacological and toxicologic studies at the Army Chemical Center (91), the University of Pittsburgh (98), and other places that have given us a body of biologic data that would not be otherwise available. Diborane and decaborane still have industrial applications whereas pen-

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AMERICAN TEXTILE
MANUFACTURERS INSTITUTE

August 3, 1998

Ms. Rockelle Hammond
Office of the Secretary
US Consumer Product Safety Commission
Washington, DC 20207

Re: ATMI Post Hearing Comments on Toxicity of Flame Retardant Chemical Treatments for Upholstery Fabrics (63 FR 18183; April 14, 1998)

Dear Ms. Hammond:

ATMI is pleased to submit these comments on the toxicity of flame retardant chemicals. Our remarks are in response to the issues raised at the Commission's May 5-6 hearing on the Toxicity of Flame Retardant Chemicals that may be used on Upholstery Fabrics. We would be pleased to answer any additional questions regarding the textile industry posed by the Commission.

HISTORY OF CPSC UPHOLSTERED FURNITURE PROJECT

ATMI has worked with the Consumer Product Safety Commission (CPSC) regarding the flammability of upholstered furniture from small-flame ignition sources for more than 20 years and we are pleased to continue working with the agency on this important issue.

TOXICITY ISSUES

Toxicity is a very complex subject. It encompasses chemistry, biology, environmental and health assessments for both consumers and workers, and an understanding of human factors.

The U.S. textile industry has some knowledge of chemistry and basic toxicity issues; however ATMI has no staff toxicologists and our member companies do not have professional toxicologists on their staffs either. They rely on chemical and fiber suppliers for information in this area.

Our industry currently uses a relatively small amount of flame retardant (FR) chemicals. Less than 0.2% of all U.S. fabric is flame retardant treated. Companies that have entered this product category do this as a niche business, addressing markets such as protective apparel and transportation fabrics like airline upholstery. Most of the fabrics that are FR treated are those constructed with 100% of one fiber (i.e., "all cotton" or "all polyester") or chiefly (> 85%) made of a given fiber.

Flame retardant chemicals are classified by their fire extinguishment mechanism. Their success depends on the fire response mechanism of the fiber (i.e., char forming fiber versus a melt-drip fiber). The majority of upholstery fabrics, however, are made from blends of fibers (i.e., polyester, cotton, rayon, nylon). Fiber blends are used because of the characteristics (i.e., softness, abrasion resistance, dye absorption) being sought in the end product. Approximately 85% of upholstery fabrics are made with blends of fibers.

Considerable research was carried out in the 1970's to evaluate various flame retardant chemicals, their mechanisms, and their potential application to textile products. The fiber/textile/textile product complex allocated large resources to this effort to try to find viable solutions to address flammability issues.[1]

List of Flame Retardant Chemicals in the CPSC Briefing Package

The CPSC provided a list of flame retardant chemicals in the briefing package (pp. 373-380), many which the Commission's March 17, 1998 *Federal Register* notice (*63 FR 13017*) notes as toxic. We are familiar with some of these products. However, we observed that two of the most common systems used on textile products, Proban® and Pyrovatex®, have not been included on this list or have been mislabeled. Proban® is incorrectly reported by the CPSC. Proban® can be several different materials: tetrakis (hydroxymethyl) phosphonium (THP) salts either prereacted with urea or another nitrogenous material (precondensate) or without reaction with a nitrogenous material. The precondensate after curing, ammoniation, and oxidation is a durable inert polymer. CPSC did not reference a NTP document on the toxicology and carcinogenesis of THP compounds (NTP, Technical Report Series No. 296 Dec. 1986). Pyrovatex® is a reactive phosphorus compound (e.g., N-methyol dimethyl phosphonopropionamide) that reacts with cellulose to form a durable product. There is no comprehensive source of toxicological data on these

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[1] Horrocks, A. R. "Flame Retardant Finishing of Textiles." *Rev. Prog. Coloration* Vol. 16, 1986, page 62.

products. For many of the chemicals listed in the CPSC report, there is limited toxicological data. Both acute and chronic toxicity data are needed in order to make a full and complete assessment about the potential use of a flame-retardant chemical.

Dr. Gary C. Stevens, Director of the Polymer Research Center at the University of Surrey, England testified before the Commission at the May hearing. Dr. Stevens acknowledged, in his statement to the Commission, that there are still many unknowns surrounding the use of flame retardant chemicals on upholstery fabrics:

> *...The human and environmental toxicology of flame retardants, in common with other chemicals, is incomplete and no comprehensive life-cycle benefit studies have been performed to date. It is important that each flame retardant is considered in the context of its incorporation into consumer products and that its human exposure and environmental life-cycle risks are assessed.*
>
> *It is not possible currently to complete the risk-balance equation for long term effects... Our level of confidence is limited because of incomplete information on the long term human exposure toxicology and environmental impact of flame retarded products and the lack of any life-cycle risk assessment experience in this field. We would recommend that these areas continue to receive attention as part of the ongoing programme on assessing existing substances in Europe and where possible the activity should be accelerated for the more commonly used flame retardants in consumer products.*

ATMI agrees with Dr. Steven's conclusions that further study on the toxicity and environmental impacts of flame retardants are warranted.

What works?

There are tens of thousands fabrics that could be manufactured when considering the number of fiber, fabric construction, and finish combinations. The upholstered furniture business is a fashion driven industry. Upholstery fabric companies change the styles in their product lines annually. Our member companies have told us that they can make 200 to 2000 fabric style changes per year. Most of our members have more than 10,000 different fabric styles in their product line. Each flame retardant treatment will have to be customized to each fabric construction, and many fabric constructions will be lost to the consumer because their pleasing aesthetic qualities will be ruined when treated. Indeed, it will be impossible for upholstery fabric producers to offer the wide range of fabrics to the consumer as they do now.

The toxicological effect that might result from applying various FR chemicals to this infinite number of fabrics is unknown. The textile industry has limited understanding of which FR chemical backcoatings will work with specific fibers (i.e., cotton, nylon, blended fabrics), fabrics (i.e., weave and construction features – pile, sheer, matelassé), and fabric treatments (i.e., specialty finishes such as water repellency and post finishing treatments such as washing and polishing).

There are numerous issues, many technical in nature, that would need to be addressed with a mandatory regulation, such as:

- treatment aspects such as chemical types, amounts, concentrations
- product development research
- processing variables and requirements
- lack of industry experience in applying FR treatments
- overall product re-engineering

As mentioned earlier, less than 0.2% of all U.S. fabrics contain flame retardant treatments. The broad industry lacks experience and knowledge about the chemicals and processes to apply these chemicals to textiles and what concentrations are needed to obtain the desired end results -- non-ignition of the furniture. These also reflect only a few fabric choices. The industry would be forced to entirely re-engineer its products to meet this regulation and to run dual manufacturing operations, as companies also export upholstery fabrics globally. Almost every nation in the world, except the United Kingdom, is void of flammability requirements for upholstery fabrics. To complicate the issue further, some countries, such as Germany, also prohibit the sale of products with some classes of flame retardant chemicals.

Many fabrics will lose their desirable properties and characteristics when backcoated with flame retardant finishes. These properties include color, softness, drape, hand and durability.

OTHER ISSUES

Who Provides Information on Safety of the Chemical?

Toxicity data on these FR chemicals will need to be developed and supplied to the textile industry by flame retardant chemical manufacturers and suppliers. Chronic and acute toxicological data are generated from chemical assessment, animal tests, and in-vitro procedures over a period of years. Virtually all toxicology studies which have been done on flame retardant chemicals are ingestion and dermal studies. Very few Inhalation studies, which would provide information on possible chemical exposure to workers, have been done. The textile industry would need to have this information provided, since it does not have the resources or expertise to do these assessments.

The toxicity testing of FR chemicals should satisfy the requirements of all applicable laws including, for example, the Federal Hazardous Substances Act and EPA Toxic Substances Control Act (TSCA).

Workplace and Environmental Considerations for Textile Finishing Operations if FR Chemical Treatments are Required

Some of the workplace and environmental considerations for FR-chemical textile processes are:

OSHA (workplace)

- Process Safety Management Standard (29 CFR 1910.119) (if ammonia or other listed chemicals are used in the process)
- Hazard Communication Standard (29 CFR 1910.1200) (MSDS, training)
- PEL for ammonia (29 CFR 1910.100 Table Z-1); formaldehyde (29 CFR 1910.1048); other chemicals (29 CFR 1910.1000). This includes monitoring, control, record keeping
- Safety and Health Management Program (training, etc.)

Preserving the safety and health of our employees is of paramount importance to our industry. We are concerned about the potential inhalation and dermal affects of these FR chemicals on our employees. The use of these chemicals may require special processing and safety equipment. ATMI is a leader in worker safety and health and has its own worker safety and health management program called "Quest for the Best in Safety and Health." More information about our Quest program is enclosed.

We are also concerned about the potential exposure to these chemicals for our downstream customers' employees in furniture assembly and interior design operations. Furniture and interior design industry employees could experience inhalation of the FR backcoatings during processing due to dust, and direct dermal contact with the backcoatings during manufacturing. Any proposed rule-making needs to examine inhalation and dermal irritation problems with some of the current FR backcoatings used in the market. Any rulemaking should also examine the possibility of carpal tunnel syndrome because of the physical exertion required to stretch back-coated fabrics, which are stiff, on to furniture.

There is also the potential health problem associated with the use of these products by consumers. Large quantities of upholstery fabrics are sold at retail, through thousands of fabric shops and more than 30,000 ASID and other interior design practices. In these cases, the consumer has direct contact with the backcoating of the upholstery fabric. Since these fabrics are sold rolled up, the backcoating has direct contact with the face surface of the fabric. Upholstery fabrics are also stored and transported in rolls and the warehousing and transportation facilities are almost never temperature controlled. Transportation and warehousing at high temperatures increase the ability of flame retardant chemicals to migrate and become bioavailable to workers and consumers.

Scanning Electron Microscopy (SEM) Image

We have enclosed a scanning electron microscopy (SEM) image of a backcoated fabric. CPSC staff noted in the December 1997 Commissioner's briefing that:

> "...however the case of potential for consumer exposure, we are talking about either skin or even oral toxicity. If exposure even takes place in the first place, it's trapped in the backcoating and our extraction studies show that it doesn't come out."

The enclosed SEM image clearly indicates that the backcoating does penetrate through fabric via the interstitial spaces between the yarns, and is present on the face of the fabric. This is a vehicle for direct contact with consumers. We are also concerned about the potential for young children to ingest FR chemicals from the fabric surface. During most chemical reactions there is stray initial reagent that does not undergo complete chemical reaction. So, it is likely that some of the initial chemical could be present in the backcoating, making it bio-available to consumers and children.

Efficacy of Flame Retardant Backcoatings

The textile industry also does not have information on the long-term durability of backcoatings or their ability to withstand chemical reactions with products such as urine, beverages, water, blood, household cleaning compounds and sebum. We are not aware of any tests on the efficacy of these flame retardant chemicals. Our experience with some latex and acrylic backcoatings indicates that they can break down within five to seven years. The durability and life of these coatings depends on temperature and exposure to abrasion, flexing, moisture, cleaning compounds, and other chemicals. Therefore, the FR chemicals could be potentially bioavailable to consumers when the backcoating breaks down. Because the average life span of furniture is 17 years, these chemicals would be bioavailable to consumers for at least as long as the life of the product.

California Proposition 65

Some of the chemicals used in latex backings and listed in the CPSC *Federal Register* notice are designated as cancer and reproductive hazards under California Proposition 65. These compounds include: antimony trioxide, di (2-ethyl hexyl) phthalate, vinyl chloride, arsenic, lead and ethyl acrylate. If the industry were forced to use these products in upholstery fabrics, it could be required, under California law, to label them as hazardous products. These labels would not be desirable for the marketing of the furniture/fabric products.

Applicable Environmental Regulations

Listed below are a number of environmental requirements for manufacturing processing and products. Our industry utilizes large quantities of natural resources such as water, air, and energy in manufacturing.

EPA (environmental)

- (Air) Clean Air Act (42 US Code 7401 et seq.)
    - NAAQS for O_3 (because of VOCs)
    - Hazardous Air Pollutant (HAP): MACT standard for textiles
    - Chemical Accident Prevention, Section 112(r) (40 CFR 68)
    - Federal Permits ("Title V" permit) (40 CFR 70)
    - State Air Permits

- (Water) Clean Water Act (33 US Code 1251 et seq.)
    - NPDES permits (40 CFR 122) (for effluents including metals, COD, BOD, TSS)
    - State Water Permits

- (Solid Waste) RCRA (42 US Code 6901 et seq.)
    - If the product is a hazardous waste or produces hazardous waste -- state solid waste permit

- Emergency Planning and Community Right-to-Know (42 US Code 11001 et seq.)
    - Toxic Release Inventory (TRI) (40 CFR 372)

ATMI member companies are committed to environmental preservation and our association takes this issue seriously. In fact, we have developed our own environmental management program called "Encouraging Environmental Excellence" or E3. Information about the E3 program is enclosed. We are the only textile association in the world that has such a program. ATMI's leadership in this area has been recognized by the US EPA and state environmental agencies:

> *"The member companies of ATMI's E3 program have demonstrated leadership in the arena of cultural change. Their commitment to minimizing their impact on the environment has had the additional benefit of cost savings and risk reduction. These companies should be commended."* -- Linda Rimer, Asst.

Secretary of the Environment, North Carolina Department of Environment, Health and Natural Resources.[2]

The proposed CPSC regulation for upholstered furniture would have a major impact on the environmental aspects of our manufacturing processes. Approximately 50% of the current population of upholstery fabrics are not backcoated. Many of the companies involved in manufacturing these products do not have backcoating operations in their plants either because the fabrics they produce are durable enough and do not need backcoating, or because the companies are not large enough to justify the costs and are forced to rely on commission finishers. These products are tactile enough to meet consumer needs. CPSC staff recently visited one of these operations. If the draft proposed rule is approved, this company would be forced to add a backcoating operation to its manufacturing facility. The state EPA office where this plant is located will not provide this company with an operating permit because this region is limiting commercial access to water. This company would be forced to use an outside contract finishing company to back-coat its fabrics.

Companies that do have some finishing operations would increase their water and energy consumption significantly to treat fabrics. One ATMI member company estimates that it would significantly increase the quantity of pollutant generated in waste during the manufacturing process. The proposed CPSC regulation would change the classification of this manufacturer from a small quantity generator to a large quantity generator. They state that waste latex backcoating is not recyclable and they estimate that their company would have the following waste in its water effluent annually: 6 lbs. of vinyl chloride; 420 lbs. of arsenic, 280 lbs. of lead, 30 lbs. of ethyl acrylate, 100,000 lbs. of antimony trioxide and 40,000 lbs. of di (2-ethyl hexyl) phthalate. They have been told by their local environmental agency that they will not be allowed to discharge this volume of chemicals and therefore, would be required to find another disposal option. If this material is disposed of off-site, it then is classified as hazardous waste and it must meet other EPA requirements. This is just one example of the situation many of our members will face if required by law to treat upholstered furniture fabrics with flame retardant chemicals.

Recycling Initiatives

Many ATMI E3 member companies are involved in recycling and waste minimization efforts. There are concerns that textile waste which has been treated with a flame retardant chemical may not be responsibly recycled.

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[2] *Encouraging Environmental Excellence Report 1996*, American Textile Manufacturers Institute, Washington, DC, page 3.

EU Ecolabeling Initiative for all Textile Products

The environmental impact of flame retardant chemicals continues to be of concern in Europe. The European Union (EU) is developing an "ecolabeling" scheme for all textile products. The primary objective of ecolabeling is to reduce a product's impact on the environment from production to disposal. ATMI is monitoring the progress of this project, in part because of its potential to create a non-tariff trade barrier for US textile manufacturers. The latest draft language of the ecolabeling criteria (May 1998) states:

> ***Flame retardants:*** *No use of flame retardant substances or preparations containing substances that are classified by the manufacturer, or can be classified on the available data as dangerous for the environment according to Commission Directive 67/548/EEC, as last amended by Commission Directive 97/69/EC.*
>
> *Alternative*
> *or No use of brominated flame retardants or antimony oxides*
> *or No use of halogenated flame retardants or antimony oxides*

Hazardous Clean-up

The CPSC has designed this draft proposed regulation to require the use of flame retardant treatments on upholstery fabrics. We are keenly aware of the consequences of the use of TRIS on children's sleepwear in the 1970's, a FR chemical used to meet the federally mandated flammability requirements on children's sleepwear. After commercial implementation, TRIS was deemed to be a potential carcinogen. Once TRIS was removed from the market, there were no still injuries associated with the flammability of children's sleepwear. The industry was forced to recall products, address legal cases for potential chemical exposure, and expedite hazardous chemical clean-ups.

ATMI is also concerned about the potential liability for hazardous clean up of FR chemicals.

We do not want history to be repeated. Therefore, if the agency mandates the FR backcoating requirement on upholstery fabrics, we ask the agency to consider establishing a legal policy on these issues and the responsibility of the affected parties.

COSTS

As noted earlier, the CPSC cost net benefit analysis omitted a number of other costs associated with the draft proposed regulation. The CPSC analysis dealt solely with the textile and furnishing industries and did not address the impact upon the thousands of fabric retailers, which are virtually all small businesses, and omitted a number of other costs. The missing costs include but are not limited to:

- re-engineering
- product development and marking costs
- capital expenditures for manufacturing space and equipment
- material costs and discontinuing the use of some product lines
- environmental costs for water & air clean-up and increased energy consumption; worker safety & health monitoring and education
- loss of export business

Preliminary estimates from one of our members suggests increased costs, for the first three items on this list, will be approximately $ 220,000,000 during the first four years after the regulation would go into affect. This does not reflect the cost increases that will be passed onto our business customers or the ultimate consumer of the products. There are more than 50 U.S. textile companies manufacturing upholstery fabrics.

Reengineering and New Equipment Costs

The industry would be required to purchase new equipment to treat these fabrics. The majority of upholstery fabric manufacturers do not post-treat fabrics after the goods are woven. New manufacturing lines would have to be installed for treating fabrics. The current U.S. capacity would not meet the demands of the regulation and there will be long delays to obtain goods.

Imported Fabrics

If this draft proposed regulation is passed, it should apply equally to domestic and imported fabrics. ATMI is concerned about how the agency would enforce this rule on imported products (i.e., furniture and upholstery fabrics) that would enter this country. We would like CPSC to provide information on how the agency will monitor compliance for imported products.

Costs of Environmental, Safety and Health Regulations

CPSC needs to assess the impact of its draft proposed regulation on the environmental, and safety and health regulations with which the industry complies. The CPSC regulation will have a phenomenal monetary impact on our industry with regard to compliance with these regulations. These costs were not included in the CPSC cost net benefit analysis during the advanced notice of proposed rulemaking, but are significant and should be added for a complete evaluation.

1997 Statistics for Consumption of Residential Upholstery Fabrics

An article in the May 1998 issue of *Upholstery Design and Manufacturing* (UDM) cites a recently published study by Keyser Ciprus Ltd., a New Haven, CT-based marketing research and consulting firm, on information on the residential and contract upholstery market. The results of this comprehensive study indicate a substantial difference in the consumption of residential upholstery fabrics from the number quoted in the CPSC briefing package..

> ...residential upholstery fabrics – used on motion, recliners, sofa sleepers, stationary upholstery, and occasional chairs – increased from 402 million lineal yards in 1993 to 403.3 million lineal yards in 1997.[3]

This estimate of 403.3 million lineal yards (605 million square yards) is about twice the estimate of 290 to 340 million square yards (about 200 million lineal yards) noted on page 485 of the CPSC October 28, 1997 Briefing Package on Upholstered Furniture Flammability:

> ...the Directorate for Economic Analysis estimates that annual consumption of upholstery fabrics for the production of upholstered furniture is in the range of 290 to 340 million square yards.[4]

This difference of approximately +203.3 million lineal yards (305 million square yards) will impact all areas of production costs and needs to be factored into CPSC's cost estimates for this potential regulation.

In addition, the report indicates that US textile manufacturers are producing residential upholstery fabrics in a greater combination of fiber blends than ever before:

> Pure cotton fabrics moved from eighth to fifth position showing renewed strength. The remaining fabrics in the 1997 top 10 list are new entrants this year. They consist of cotton/polyester blends, cotton/polypropylene blends, and acrylic/polyester blends.[5]

According to the Keyser Ciprus Ltd. Study, blends outranked pure fibers and contributed 249.5 million lineal yards to the 403.2 million lineal yards of residential seating fabric produced.[6] New combinations of fiber blends and

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[3] "The Color of Upholstery", *UDM Upholstery Design and Manufacturing*, May 1998, page 34.
[4] Consumer Product Safety Commission. Regulatory Options Briefing Package on Upholstered Furniture Flammability, Oct. 28, 1997, p. 485.
[5] "The Color of Upholstery", *UDM Upholstery Design and Manufacturing*, May 1998, page 37.

[6] "The North American Market for Contract & Residential Upholstery Fabric." Keyser-Ciprus, Ltd., November 1997.

consumer preferences complicate the processing technology challenges for flame retardant finishing faced by the textile industry.

ALTERNATIVE SOLUTIONS

Incidents of fire-related death and injuries might be reduced by other means than just by the use of flame retardant chemicals in consumer products.

Consumers are a critical link. They must be engaged in assessing the risks and finding solutions. They can be educated about the relationship of high-risk behavior and its impact on fire deaths and injuries. Consumers can reduce their fire risk by using smoke detectors, exercising home safety maintenance, reducing the use of small-flame sources and smoking materials in their homes, and by developing emergency egress response plans.

Consumers should be informed about this potential regulation and their possible exposure to flame retardant chemicals. They should be invited to discuss this potential regulation and evaluating solutions to the fire problem.

We thank the commission for the opportunity to offer comments on this subject. We would be happy to address any questions you may have.

Sincerely,

Patty K. Adair

Patty K. Adair
Asst. Director, Textile Products & Standards

Attachments:

1. SEM image of backcoated fabric
2. Brochure, ATMI's Quest for the Best in Safety and Health
3. Brochure, ATMI's Encouraging Environmental Excellence (E3) Program

Fire Retardant Chemicals Association
FIRE SAFETY THROUGH CHEMICAL TECHNOLOGY

851 New Holland Avenue ■ Box 3535 ■ Lancaster, Pennsylvania 17604 ■ (717) 291-5616

FACSIMILE (FAX) NUMBER (717) 295-9637

August 3, 1998

Office of the Secretary
U. S. Consumer Product Safety Commission
Room 502
4330 East West Highway
Bethesda, MD 20114-4408

RE: Revision of Information Submitted on July 15, 1998 From Fire Retardant Chemicals Association

Dear Sir/Madam:

Mr. Dale Ray of CPSC had a question concerning the indication that flame retardant chemicals were used in the United States for fabric going into Residential Furniture. This information appeared on the list of Textile of Applications using flame retardants within the United States.

The flame retardants in question, (antimony oxide, decabromodipheny oxide and hexabromododecane) were actually sold for application within the United States. It is strongly suspected that the coated fabric was shipped to Euope to be used in Residential Furniture to be sold in Europe (probably the UK) for Residential furniture.

We have revised the application sheet for these three products with a footnote indicating that the final end use was probably not in the United States.

We hope that this explanation helps CPSC to evaluate the information on the textile applications documents.

Sincerely,

Russell C. Kidder
Executive Vice President

RCK/jaf
Cc: Dale Ray, CPSC
Michael Babich, CPSC
Blake Biles, Arnold & Porter

Fire Retardant Chemicals Association
FIRE SAFETY THROUGH CHEMICAL TECHNOLOGY

851 New Holland Avenue ■ Box 3535 ■ Lancaster, Pennsylvania 17604 ■ (717) 291-5616
FACSIMILE (FAX) NUMBER (717) 295-9637

July 15, 1998

Office of the Secretary
U. S. Consumer Product Safety Commission
Room 502
4330 East West Highway
Bethesda, MD 20114-4408

RE: Flame Retardants for Textile Applications

Dear Sir/Madam:

The Fire Retardant Chemicals Association (FRCA) presents these comments in response to questions raised by CPSC at the May 5-6, 1998 workshop on toxicity of flame retardants. As stated previously, FRCA continues to strongly support a mandatory small open flame performance standard for residential upholstered furniture, in order to save lives (and property damage) from the numerous residential fires which continue to occur because of the absence of such a standard.

The information which we are providing is based upon input received from those companies which have informed FRCA that they do market one or more flame retardant (FR) products for use in various textile applications. For most flame retardants there are two or more producers, while for others there may be only one. We have surveyed all of these companies which have indicated marketing activities with the textile industry. We received responses from most of the companies and, we believe that a consensus can be determined from the responses.

Enclosed are two documents:

(1) A List of Textile Applications Using Flame Retardants Within the United States and Outside of the United States in 1997, organized into sixteen (16) product categories, based upon the sixteen (16) key products for which general information was presented to CPSC at the May 4-5, 1998 workshop. This list was compiled from information supplied by producers of flame retardants marketed to the textile industry.

(2) Estimated Consumption, in 1997 of FR Chemicals Used in Textile Applications in the United States. The total consumption of flame retardants for textile applications has been segmented into carpet and all other applications. This segmentation has been done because the consumption of FR products in carpet in larger than in any other textile use with over half of the textile application.

This consumption data is only an estimate as there is no single source for this information. Although the exact consumption number is not known, the estimates given do indicate the approximate consumption volume.

FRCA does not have direct knowledge of all of the textile applications for flame retardants nor the estimated volume of flame retardants used in textile applications. However, we gladly will act as the conduit to collect information from FR producers (both members and nonmembers of FRCA), and to pass this information on to CPSC.

There is other requested information being supplied directly to CPSC by individual companies. This is being done in this manner because this information resides with these companies and is not considered confidential to any one category.

FRCA appreciates the opportunity to provide the information requested by CPSC on the use of flame retardants in the textile industry. If CPSC has any additional information concerning the use of flame retardants in textile applications, please contact me at (717) 291-5616, and I will try to obtain the information.

Sincerely,

Russell C. Kidder
Executive Vice President

RCK/lpy

Cc: Dale Ray, CPSC
Michael Babich, CPSC
Blake Biles, Arnold & Porter

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Submitted to:

U. S. Consumer Product Safety Commission

Prepared by:

Fire Retardants Chemicals Association

July 1998

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LANCASTER, PENNSYLVANIA 17604

FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Antimony Oxide

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X[1]	X
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets	X	X

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[1] The reported slaes of Antiomy Oxide in the U.S. for use on textile fabric used on residential furniture was for chemical sale and application to fabric in the U.S.; however, it is quite likely that most of the coated fabric was used outside of the U.S. for residential furniture.

FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Applications

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture	X	X
Children's Sleepwear	X	
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	
Carpets	X	

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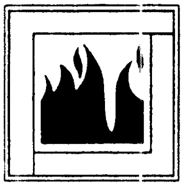

FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications
by Product Classes for 1997
Within and Outside of the United States

[illegible]	[illegible]

Textile Applications	Used Within the United States	Used Outside the United States
Residential Furniture		
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets	X	X

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Decabromodiphenyl Oxide

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X[1]	
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets	X	X

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[1] The reported slaes of Decabromodiphenyl Oxide in the U.S. for use on textile fabric used on residential furniture was for chemical sale and application to fabric in the U.S.; however, it is quite likely that most of the coated fabric was used outside of the U.S. for residential furniture.

FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Hexabromocyclododecane

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X[1]	X
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets		

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[1] The reported slaes of Hexabromocyclododecane in the U.S. for use on textile fabric used on residential furniture was for chemical sale and application to fabric in the U.S.; however, it is quite likely that most of the coated fabric was used outside of the U.S. for residential furniture.

FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Tri (Beta Chloropropyl) Phosphate

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture		X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)		
Other Transportation		X
Draperies		X
Wall Coverings		
Carpets		

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	[illegible] (1,3-Dichlor[illegible]) Phosphate

Textile Applications	Used Within United States	Used Outside The United States
Residential Furniture		X
Commercial Furniture		X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	
Other Transportation		X
Draperies	X	
Wall Coverings	X	
Carpets		

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Halogenated Olefins and Paraffins

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		
Commercial Furniture		
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	
Other Transportation		
Draperies	X	
Wall Coverings		
Carpets		

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Alumina Trihydrate

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X	X
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets	X	X

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Magnesium Hydroxide

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X	
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)		
Other Transportation		
Draperies	X	
Wall Coverings		
Carpets		

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Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Aromatic Phosphate Plasticizers

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture	X	
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	X
Carpets	X	X

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Ammonium Polyphosphate and Blends

Textile Applications	Used Within the United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture	X	X
Children's Sleepwear		
Other Apparel		X
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings		X
Carpets		X

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Organic Phosphonates

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture	X	X
Children's Sleepwear	X	X
Other Apparel	X	X
Automotive (Including Truck)	X	X
Other Transportation	X	X
Draperies	X	X
Wall Coverings	X	
Carpets		X

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Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Tetrakis(Hydroxymethyl) Phosphonium Salt (THPX) Precondensates With Urea

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		
Commercial Furniture		
Children's Sleepwear	X	X
Other Apparel	X	X
Automotive (Including Truck)		
Other Transportation		X
Draperies		X
Wall Coverings		
Carpets		

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Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class:	Phosphonic Acid, (3-[[(Hydroxymethyl) Amino]-3-Oxopropyl]-, Dimethyl Ester

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture	X	X
Children's Sleepwear	X	X
Other Apparel	X	X
Automotive (Including Truck)		
Other Transportation	X	X
Draperies	X	X
Wall Coverings		
Carpets		

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FIRE RETARDANT CHEMICALS ASSOCIATION

Textile Flame Retardant Applications by Product Classes for 1997 Within and Outside of the United States

Product Class	Calcium and Zinc Molybdates

Textile Applications	Used Within United States	Used Outside the United States
Residential Furniture		X
Commercial Furniture		X
Children's Sleepwear		
Other Apparel		
Automotive (Including Truck)		X
Other Transportation	X	X
Draperies	X	
Wall Coverings		X
Carpets	X	

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Fire Retardant Chemicals Association

Estimated Consumption in 1997 of FR Chemicals Used in Textile Applications in the United States

[illegible]	[illegible]
Carpets	**120 - 130**
(Listed separately because consumption is a very large part of total textile market)	
All Other Textile Applications Including:	**45 - 60**
Transportation	
Apparel	
Home Furnishings	
Draperies	
Wall Coverings	
Bedding	
Other	
Total Estimated FR Consumption Textile Applications in the US	**165-190 Million Pounds**

July 1998

Information Supplied by the Fire Retardant Chemicals Association