CPSC MEETING LOG
UPHOLSTERED FURNITURE

Meeting Between: CPSC staff and attendees at the Business Communications Co Conference on Fire Retardancy of Polymeric Materials

Date of Meeting: May 22, 2001

Meeting Site: Holiday Inn Select, Stamford CT

Log Entry By: Dale R. Ray, Project Mgr., EC, (301) 504-0962 x1323

Participants: Prof. Menachem Lewin, Polymer Research Center, Polytechnic Univ., conference director
Dr. Dennis Price, Technical session chairman
Dale Ray, CPSC
+ about 75 representatives of flame retardant chemical companies, academic researchers, fire protection consultants and other fire safety organizations

Summary:

The Business Communications Co., Inc., of Norwalk, CT sponsored this annual conference on flame retardancy. Speakers presented technical papers and discussed various issues of interest to the FR chemical industry. Copies of the conference program and attendance list are attached.

Mr. Ray presented a paper on the "CPSC Staff Risk Assessment of FR Chemicals in Upholstered Furniture," and discussed the staff's progress in evaluating FR chemicals that may be used in upholstery fabrics to meet a possible small open flame furniture standard. He noted that exposure data were needed to complete the staff's evaluation of two FR compounds (antimony trioxide and tetrakis hydroxymethyl phosphonium chloride), and reported that the staff was requesting the assistance of manufacturers to develop that information. Copies of Mr. Ray's paper and presentation slides are also attached.

Mr. Ray responded to a number of questions, including questions about the chemicals being evaluated by the CPSC staff, the nature and methods of exposure testing, the relation of CPSC's work to the National Academy of Sciences (NAS) risk assessment completed in 2000, and the flammability performance specifications of the CPSC staff's draft small open flame standard. Many of the attendees expressed interest in obtaining and reviewing the risk assessment conclusions and other data to be contained in an upcoming staff briefing package to the Commission on this project.

Attachments

12th YEAR

FLAME RETARDANCY

The Twelfth Annual BCC Conference on Flame Retardancy

RECENT ADVANCES IN FLAME RETARDANCY OF POLYMERIC MATERIALS

Materials, Applications, Research and Industrial Developments, Markets

Holiday Inn Select, Stamford, Connecticut—May 21, 22, 23, 2001

The complete technical/commercial development meeting on flame retardancy.

Presentations at the conference will:

- Create a forum for introducing new technological achievements and developments in the field of flame retardancy.
- Review the current state of science and technology in FR.
- Review the applications and markets for FR products.
- Present recent developments in local and global standardization and in testing technology.
- Discuss toxicity and environmental issues.
- Provide a unique opportunity for newcomers to FR research technology and marketing to become acquainted with the FR field in all its aspects.
- Discuss halogen-based and nonhalogen-based flame-retardant chemicals, synergism, intumescence, FR mechanisms, modelling, flame parameters, inherently FR polymers and polymer blends.

Sponsored by

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Program Chairman: Professor Menachem Lewin, Polytechnic University

THE 2001 CONFERENCE ON FLAME RETARDANCY OF POLYMERIC MATERIALS

Program as of May 18, 2001 (Subject to change)

✍ PREREGISTRATION—SUNDAY 6:00-8:00 pm (Join us for wine and cheese reception); MONDAY 7:30-8:15 am

8:15-8:30 am – OPENING REMARKS

Prof. Menachem Lewin, Polymer Research Institute, Polytechnic University, Brooklyn, NY.

Session I
REVIEWS AND GENERAL LECTURES
May 21, 2001 am

Chairman: Professor Gordon Nelson

8:30-9:00 am

STUDIES ON THE COMBUSTION BEHAVIOUR OF SOME NOVEL FLAME RETARDED POLYMER SYSTEMS

D. Price, K. Pyrah, T.R. Hull and G.J. Milnes, Institute for Materials Research (Chemistry), University of Salford, England and J.R. Ebdon, B.J. Hunt and P. Joseph, Chemistry Department, University of Sheffield, Dainton Building, Brook Hill, Sheffield S3 7HF, England.

The Salford Fire Chemistry Group is applying its range of experimental techniques to assess the fire performance of copolymers with phosphorus-containing groups in their structure. For comparison purposes, the flame retardance and mechanical properties of the base polymer system containing additive flame retardants with the phosphorus in the same chemical environments are also studied. Results show the reactive approach yields phosphorus-containing copolymers having significant flame retardance and little deterioration in mechanical properties, although the additive approach results in significant loss in mechanical properties.

9:00-9:30 am

SUBSTANTIVE INTUMESCENTS FOR FIBRE-FORMING POLYMERS

A. Richard Horrocks and Sheng Zhang, Bolton Institute, UK.

Application of intumescents to fibers and textiles more often than not requires their inclusion in a surface-bonding resin in order to create acceptable levels of durability. This is a consequence of their solubility in aqueous media coupled with the difficulty of including them as additives within a synthetic fibre. Also their often multi-component character because of the difficulty of synthesizing a char source, the acid-generating species and gas-forming moiety into one single molecule. Surface coatings have deleterious affects on fabric aesthetic properties. This paper discusses a development by which the introduction of substantive intumescence into flame retardant cotton fibres may be undertaken by conversion of the durable flame retardant already present into one having enhanced char-forming and some intumescent characteristics.

9:30-10:00 am

PROGRESS IN NYLON FLAME RETARDANCY

Sergei Levchik, Galina Levchik, Belarussian State University, Minsk, Belarus, Edward D. Weil, Polytechnic University, Brooklyn, NY.

Two of the authors have recently published a detailed review and the highlights will be discussed here. While aromatic polyamides are successful, modification of the aliphatic polyamide stucture has been often attempted but seems to fail for reasons mainly of cost. Chlorine- and bromine-containing additives with a variety of synergists have been successful. Somewhat successful alternatives include magnesium hydroxide, red phosphorus and melamine derivatives. A search for stable effective additives has led to R&D on phosphorus oxynitride and some newer melamine compounds.

10:00-10:30 am **Coffee Break**

10:30-11:00 am

COMBINATORIAL APPROACHES TO MATERIALS FLAMMABILITY RESEARCH

Marc R. Nyden and Jeffrey W. Gilman, Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, MD.

Recently, we have initiated a program of research to develop high-throughput methods for the formulation and flammability screening of multicomponent polymer blends and nanocomposites. This approach provides us with the opportunity to explore compositional space and to thus achieve a more complete understanding of the interactions that gov the ultimate performance of multicomponent materials. will report on our efforts to determine optimal compositio.. and conditions for the parallel synthesis.

11:00-11:30 am

REACTION-TO-FIRE TESTING AND MODELING FOR WOOD PRODUCTS

Mark A. Dietenberger, Research General Engineeer, Robert H. White, Supervisory Research Wood Scientist,USDA, Forest Service, Forest Products Laboratory Madison, WI.

In this review we will primarily discuss our use of the oxygen consumption calorimeter (ASTM E1354 for cone calorimeter and ISO9705 for room/corner tests) and of modeling reaction-to-fires to evaluate treated wood products. With recent developments towards performance-based building codes, new methodology requires engineering calculations of various fire growth scenarios. We discuss results on further specialized tests for resolving fundamental inadequacies in modeling fire growth of wood products.

THIS CONFERENCE IS AN EXCELLENT PLACE TO LEARN WHAT'S NEW AND MEET THE INDUSTRY EXPERTS.

COMMENTS BY SOME CONFERENCE ATTENDEES:

- BCC puts on a great conference. Great collection of talent and knowledge. Will attend next year.
- Very good—excellent.
- Very good atmosphere for discussion.
- This program is excellent! The program and material will be very helpful.
- Excellent opportunity to meet and discuss flame retardants with leading experts in the field.
- Extremely useful overview of the latest developments.

11:30-12:00 noon

Fire Resistant Glazing- An Overview of Thermolytic and Pyrolytic Behaviour of Different Transparent Fire Resistant Materials

r. Sukumar Varma, Fire Glazing Technology Group Building Products R & D, European Technical Centre, Pilkington Plc.

The use of fire resistant glazings within the construction and building refurbishment markets is continually increasing. New Regulatory and Test Standards are being constantly upgraded and becoming more sophisticated in assessing fire-resistant materials in general. Therefore it is of paramount importance to gain an understanding of how different materials used for this purpose behave in a fire scenario in order to make better informed choices.

12:00 noon-12:30 pm

Mechanistic Studies of Fire Retardants In The Gas Vapor Phase

Ed Metcalfe, Clive Smith and John Tetteh, University of Greenwich, U.K.

Our earlier studies on degradation kinetics during polymer combustion have highlighted some of the mechanistic aspects of the formation of toxic species such as cyanides and isocyanates. Studies highlight volatile phosphorus-based flame retardants and model compounds such as trimethylphosphate, with model hydrocarbon fuels simulating polymers and degradation products. On-line FTIR spectroscopy has been used to monitor reactant and product concentrations. We describe how quantitative target factor analysis is used for this purpose.

?:30-1:30 pm **Lunch**

Session II
INHERENT FR POLYMERS
May 21, 2001

Chairman: Dr. Marcelo Hirschler

1:30-2:00 pm

A Novel System For Flame Retarding Polyamides

Menachem Lewin and Jiri Brozek; Polymer Research Institute, Polytechnic University, Brooklyn, New York, and Marvin M. Martens, DuPont de Nemours, Parkesburg, WV.*

**Present address: Institute of Chemical Technology Prague, Chech Republic.*

Some results on a novel system for flame retarding polyamides are presented. According to this system 1.5-2.5 wt.% of ammonium sulfamate (AS) or diammoniumimidodisulfonate (DIBS) together with a small amount (1.0 wt.%) of a charring agent, such as pentaerythritol or its derivative, yield fully flame retardant polyamide 6 and 66. Thermoanalytical data are presented and some anlytical results on the gaseous pyrolysis products are shown.

2:00-2:30 pm

Graphite-Polymer Nanocomposites: A Comparison with Clay-olymer Systems.

Dr. Charles J. Wilkie, Department of Chemisty, Marquette University, WI.

Graphite-polymer nanocomposites have been prepared using two different precursors and these are compared and compared with the analogous systems obtained using clays.

2:30-3:00 pm

A New Fire Resistant Epoxy

R.E. Lyon, L.M. Castelli, and R.N. Walters, Fire Safety AAR-422 Federal Aviation Administration, W.J. Hughes Technical Center, Atlantic City International Airport, NJ.

The thermal, mechanical, and fire properties of a new epoxy derived from 1,1-dichloro-2,2-bis(4-hydroxyphenyl)ethylene (bisphenol-C/BPC) are reported and compared to values for bisphenol-A (BPA) epoxies. The BPC and BPA epoxies have identical thermal and mechanical properties but the BPC epoxies exhibit superior ignition resistance and 50% lower heat release rates compared to the corresponding BPA epoxy. The BPC epoxy cured with methylenedianiline (MDA) had a limiting oxygen index (LOI) of 30-31, exhibited UL 94 V-0/5V behavior and easily passed the FAA heat release requirement for aircraft interior materials.

3:00-3:30 pm **Coffee Break**

3:30-4:00 pm

Self-Extinguishing Epoxy Resins without Flame Retardants: Their Potential Application in Electronic Components

Yukihiro Kiuchi and Masatoshi Iji, Environment Technology Laboratories, NEC Corporation, Japan.

Environmentally friendly epoxy resin compounds without flame retardants such as halogen and phosphorous derivatives have been developed for electronic components. The compounds include phenol-aralkyl-type epoxy resins and hardeners, both containing aromatic substituents in their novolac-type structure. They show self-extinguishing properties and are highly safe when burned and disposed of. Application to molding resins for integrated circuits and substrates for printed wiring boards resulted in components with high flame retardancy and other good characteristics for practical use.

4:00-4:30 pm

Studies of Plasma Applied Polymer Fire Retardant Coatings

C. Jama, A. Quede, O. Dessaux, P. Goudmand, R. Delobel and M. Le Bras, Universite des Sciences et Technologies de Lille, Ecole Nationale Superieure de Chimie de Lille, Laboratoire de Genie des Procedes d'Interactions Fluides Reactifs-Materiaux , France.

Study investigates the thermal stability of the organosilicone thin films obtained from polymerization of 1.1.3.3-tetramethyldisiloxane monomer doped with oxygen using a cold remote nitrogen plasma process. The thermal degradation behaviors of deposits under pyrolytic and therm-oxidative conditions show that the residual weight evolution with temperature depend drastically on the chosen atmosphere. Higher amounts of a solid residue are obtained under air, which demonstrates that atmospheric oxygen participates to the degradation mechanism Limiting Oxygen Index and cone calorimetry results show that deposits are efficient fire retardant coatings.

4:30- 5:00 pm

Cell Surface Area and Foam Flammability

Martha K. Williams, Gordon L. Nelson, James R. Brenner, Erik S. Weiser, and Terry L. St. Clair. NASA, Labs and Testbeds, Kennedy Space Center, FL, Florida Institute of Technology, Melbourne, FL, NASA, Langley Research Center, Hampton, VA.

While polyimide properties have been studied previously, the majority of the data relate to films and not foams. Foams have much more surface area and thus are a greater challenge to fire retard. Because of the intrinsic flame retardancy of aromatic polyimides, one has the ability to investigate the effects

of changes in density, surface area, and chemical structure on their properties. Radiant panel and cone calorimeter data show that differences in surface area and cell size appear to have a larger effect than density or differences in chemical structure.

5:00-6:30 pm **Reception**

Session III
HALOGEN/NON-HALOGEN-BASED FLAME RETARDANTS
May 22, 2001

Chairman: Dr. A. Richard Horrocks

8:30-9:00 am

Fire Retardant Efficiency and Properties of Aliphatic Bromine Compounds in Styrenic Copolymers

I. Finberg, Y. Bar Yaakov and P. Georlette, DSBG, Beer Sheva Israel, G. Squires, T. Geran Ameribrom, Fort Lee, NJ.

A wide span of good retardancy levels can easily be achieved by the use of brominated fire retardants particularly efficient in styrenic copolymers. Aliphatic bromine containing fire retardants are very efficient in reducing burning times but do not prevent dripping. They are recommended for applications where the UL 94 class V-2 is required. DSBG is now introducing applications with tris(tribromoneopentyl) phosphate combining 70% bromine with 3% phosphorus and a melting point of 180°C. Its molecular structure provide outstanding thermal and light stability. They are not expected to pose any risk to health or the environment.

9:00-9:30 am

An Attempt at a Balanced View of the Halogen Controversy (2001)

Edward D. Weil, Polytechnic University, Brooklyn, NY.

Halogen-containing plastics and halogenated flame retardants are still subject to a lively and ongoing controversy. Since our reviews in 1999, there has been new environmental and toxicological data, risk assessment by governmental and non-governmental groups, new waste disposal proposals, improved waste disposal methodology, R&D on alternative materials, as well as activist proposals for drastic actions. Industry has developed halogen and non-halogen products which are alternatives. Some fire hazard information has been developed on electronic products lacking flame retardants. Much R&D around the world has been stimulated by this controversy, and some new products are entering the market.

9:30-10:00 pm

EVA Nano Composites Display Improved PR Properties

Dr. Gunter Beyer, Kabelwerk EUPEN AG, Belgium.

Compounds based on ethylene vinyl acetate copolymers (EVA) and layered silicates (montmorillonites) modified by various alkylammonium cations were processed by mechanical kneading in internal mixers and extruders. Depending on the alklammonium nature, microcomposites or nanocomposites were obtained. Thermogravimetric analysis performed under different atmospheres shows the increase in thermal stability of the layered silicate-based nanocomposites. Cone calorimetry was studied to investigate their flame retardant properties. Nanocomposites show a dramatic increase in the reduction of heat release and further improvements on other important fire-parameters.

10:00-10:30 am **Coffee Break**

10:30-11:00 am

Zinc Borate As a Fire Retardant in Epoxy Systems

Kelvin K. Shen, Ph.D., U.S. Borax Inc.

The use of zinc borate as a flame retardant and smoke suppressant in both halogen-containing and halogen-free epoxy systems will be reviewed. Its applications include intumescent coatings, flooring products, encapsulant for electronic components, printed-circuit boards, etc.

11:00-11:30 am

Highly Brominated Organonitrogen Compounds As Potential Synergistic Flame Retardant Agents.

Bob A. Howell, Center for Applications in Polymer Science, Central Michigan University, Mt. Pleasant, MI.

Flame retardant agents which combine good gas-phase activity with the ability to promote char formation have the potential for superior performance at lower loading than that necessary for compounds displaying only a single mode of action. Nitrogen compounds have been used in combination with organohalogen flame retardants to achieve solid phase activity while preserving the gas phase effectiveness of hydrogen halide/halogen atoms. Compounds that contain high levels of both nitrogen and bromine may confer effective dual-action flame retardancy.

Session IV
CONSUMER FOCUS INDUSTRIAL APPLICATIONS
May 22, 2001

Chairman: Dr. Dennis Price

11:30-12:00 noon

Plenum Cable: A Review of the Past and Predictions for the Future

D. Harrison (Dave) Paul, Applied Chemical Technology, St. Louis, MO.

12:00 noon-1:30 pm **lunch**

1:30-2:00 pm

Performance Requirements for Fire Safety of Materials in U.S. Navy Ships and Submarines

Usman Sorathia, Fire Protection/Sea Survival Branch, Naval Surface Warfare Center, Carderock Division, G. Long, B. Scholl, M. Blum, J. Ness, T. Graclk, West Bethesda, MD.

To facilitate the introduction of new and modified fire tolerant materials/systems/designs, and to reduce the financial burden on small business, the U.S. Navy has developed a low cost composite system fire screening protocol which offers the potential of predicting full scale fire performance. Fire growth potential of new composite systems and design can be screened by using small-scale test data from one calorimeter (ASTM E 1354) and Lateral Ignition Flame spread Test (ASTM E 1321) in conjuction with the Composites Fire Hazard Analysis Tool (CFHAT). The small-scale Burn-Through test (2x2ft) was shown capable of screening fire resistance performar determined in furnace testing with UL 1709 fire curve.

2:00-2:30 pm

Spray-on, Non-permanent, Fire Retardant for Residential Siding

Arthur F. Grand, Omega Point Laboratories, Inc., Elmendorf, TX.

Wood Siding was the primary substrate evaluated in this study, with some additional testing on vinyl siding. The test protocol involved subjecting one meter square specimens to heat fluxes of 15 and 25kW/m2 in the presence of an open-flame ignition source, using a modified ICAL apparatus (ASTM E1623). Time delay to ignition of the treated specimen was the primary measured property, while mass changes prior to and during the fire exposure also were recorded. The gel-water treatments extended the times to ignition of painted wood siding.

2:30-3:00 pm

CPSC Risk Assessment of FR Materials in Upholstered Furniture

Dale R. Ray, Project Manager, U.S. Consumer Product Safety Commission, Bethesda, MD.

The U.S. Consumer Product Safety Commission (CPSC) is developing a possible flammability performance regulation for upholstered furniture. Residential fires in which upholstered furniture was the first item ignited account for more fire deaths than any other category of consumer products; total societal costs in 1998 were over $3.5 billion. As a part of the standards development process, the CPSC staff assessed potential health risks associated with the use of FR compounds that may be used in upholstery fabrics to meet a new standard. CPSC also sponsored a study of toxicological risks by the National Academy of Science; the findings were incorporated into the CPSC staff risk assessment.

3:00-3:30 pm **Coffee Break**

3:30-4:00 pm

Flame Retardant Composites Boards with Vermiculite

Ryszard Kozlowski, Bozena Mieleniak and Alojzy Przepiera, Institute of Natural Fibres, Poznan, Poland.

Results presented in this paper are focused on developing lignocellulosic boards by using amino resins with reduced level of formaldehyde emission, which are based on flax shives, waste wood particles and vermiculite in unexpanded and expanded forms. The effect of different ratios of mineral particles to lignocellulosic ones and different fractions of both unexpanded and expanded vermiculite on flammability and physical and mechanical properties of homogeneous and three-layer boards was investigated. This resulted in developing production technology of three-layer composite boards.

4:00-4:30 pm

European Regulatory Activity Regarding Brominated Flame Retardants, and Its Effect On The Flame Retardant Chemicals Industry

Terry Hull, Editor, Flame Retardancy News, BCC, Inc.

One of the most interesting dramas in the theater of the flame retardant chemicals industry is the controversy regarding alleged dangers of brominated flame retardants. Center stage for that drama is Europe. A growing chorus of consumer and environmental activists are voicing a variety of concerns about the effects of brominated chemicals on health and the environment. They especially target the use of bromine-based products in polycarbonates and other plastics used in computers and other electronic devices. The European Commission's proposed WEEE (Waste of Electrical and Electronic Equipment) Directive gives prominent attention to brominated retardants. Manufacturers of brominated retardants respond that possible dangers have been linked to only a few of the dozens of brominated retardants on the market. This report presents an update on the status of the WEEE directive, activism against brominated retardants, and how manufactures are responding to the controversy.

4:30-5:00 pm

Testing of Cotton Bales to Evaluate Flammability and Hazard Potential

P.J. Wakelyn, Senior Scientist, National Cotton Council, Washington, DC, USA and S.E. Hughs, Research Leader, USDA, ARS, Mesilla Park, NM, USA.

Bales of cotton were classified by International Maritime Organization (IMO) code regulations as a flammable solid (Class 4.1.), which required hazardous goods papers to accompany waterborne shipments. This IMO regulation was based on anecdotal evidence and historical beliefs not substantiated by science. Cigarette, match, and open flame (CA TB 129/ ASTM 1590) tests were conducted; the potential for self heating and spontaneous combustion was evaluated; and the potential of cotton bales sustaining smoldering combustion in their interiors at various compression densities was studied. Flammability evaluations led to IMO removing this designation for bailed cotton [compressed to a density of 360kg/m3 (22.4 lbs/ft3) or greater; meets ISO 8115], effective Jan 1, 1999.

5:00-6:30 pm **Reception**

Session V
STANDARDS AND TESTING
May 23, 2001

Chairman: Dr. Kelvin Shen

8:30-9:00 am

The Flammability of Raised Surface Cotton Apparel: Regulations, Issues, and Control Options

William A. Rearick, Michele L. Wallace, Vikki Martin, Cotton Incorporated, Dr. Phil Wakelyn, National Cotton Council.

About 65% of the adult garments recalled by the Consumer Products Safety Commission (CPSC) since 1980 for flammability reasons (16 CFR 1610), have been cotton or cotton blends. Over 45% of these items were fleece, and 75% were raised-surfaces apparel. 1999 data indicates, 374,000 bales out of 979,000 bales of fiber used in fleece apparel, were cotton. There is significant interest in 100% cotton raised surface garments that pass flammability tests. This research includes evaluation of chemical treatments that are successful for other cotton substrates and new chemical systems.

9:00-9:30 am

A New Generation of Fire-Resistant Seat Cushioning for Airline Industry

Chandrasiri Jayakody, Dan Myers, Malcolm Crocker, Jeff Bridge and Carl Ogburn, Chestnut Ridge Foam, Inc., Latrobe, PA.

A new generation of low density, open-cell, fire-resistant aircraft seat cushioning materials has been developed. Airflex® is manufactured in distinct seat and back cushioning selections, in a variety of colors for a variety of firmness choices. The new foam materials will easily meet fire-testing standard required by the Federal Aviation Administration. Fire-resistant properties and physical properties of these polyurethane-

polychloroprene hybrid foam materials will be discussed.

9:30:10:00 am
Flammability, Electrical Properties, and Resistance to Ignition of Polymeric Materials, UL, 94, UL 746A, and UL 746C
John Stimitz, Underwriters Laboratories, Inc. Melville, NY.
An overview of the Flammability levels of polymeric materials, and electrical properties. A review of the test methods used for the determination of the resistance of ignition from electrical sources and electrical properties. Also presented will be an overview of new activities and recent developments pertinent to the plastic categories.

10:00-10:30 am **Coffee Break**

10:30-11:00 am
Studies of FR Polyester Resins Using Cone Calorimetry
P. A. Atkinson, P.J. Haines, G.A Skinner, Kingston University, Kingston, UK & J.P. Redfern, Director, F.I.R.E. Ltd., Orpington, UK.
Polyester resins suffer from their inherent flammability. The effects of using halogenated monomers and of incorporating fire retardant additives have been studied by a wide range of methods. Tin compounds have been shown to be effective flame retardants and smoke suppressants, especially with halogenated polyester resin systems through studies at the International Tin Research Institute and by others. This paper reports a comprehensive study of fire behavior using a cone calorimeter which has been carried out on resins with and without tin-based additives. The changes in ignition behavior, heat release rate, smoke and gas emissions have shown significant advantages for these additives.

11:00-11:30 am
Modeling toxicity of Various Large Scale Fire Conditions Using The Purser Furnace
T. Richard Hull, Irene G. Areri and David A. Purser, Institute for Materials Research, University of Salford, U.K.
A Purser furnace is being used to investigate the combustion toxicity of a range of C, H, O-containing polymers. The effect of fire conditions has been investigated in terms of the equivalence ratio Ø. In many cases the CO evolution is dependent solely on the equivalence ratio, and independent of the chemical structure of the polymer. The carbon monoxide yield of the fire gases increased with increase in fuel-air ratio. For PE, PP, PMMA and 19% EVA and 26% EVA, the CO evolution was independent of the polymer and depended only on Ø ratio. PS gave higher CO yields at low fuel/air ratios, and lower CO yields at high fuel-air ratio in comparison with the other polymers studied. The CO yield translates to a fractional effective dose, showing a three fold increase in the fire toxicity in going from fuel lean (Ø=0.5) to fuel rich (Ø=1.5) conditions. Currently, the influence of hydrated metal oxide fire retardants on the combustion toxicity is being studied.

11:30-12:00 noon
Determining the Fire Safety of a Material Via Hazard Assessment
Marcelo M. Hirschler (GBH International, Mill Valley, CA) and Donald J. Hoffmann and John M. Hoffman (Safety Engineering Labs, Warren, MI.)
When applications with fire safety implications were proposed for a certain material, questions were raised as to its suitability. Cone calorimeter tests were conducted and the results used to analyze whether to recommend the materials for use within 4 applications: exterior finish, interior finish, automotive transportation and airport terminal seating. The material was found safe for three of the proposed applications, and that it could also be used, with some limitations, in the other.

12:00 noon-12:30 pm
Flammability Studies of Fire Retardant Coatings Using Cone Calorimeter
J. Koo, W. Wootan, W. K. Chow (2), H. W. Au Yeung (2), and S. Venumbaka (2) Center for Environmental and Industrial Science Southwest Texas State University, 2) Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong, China.
This paper describes as an attempt to use Mass Loss Cone Calorimeters to study new FR coating and optimize the thickness of these coatings based on ASTM E-84 test conditions. Several ASTM E-84 Class A materials were used for control materials and were compared with different systems under the same testing conditions of the Mass Loss and Cone Calorimeters. The Calorimeter data were compared between two sets of FR coating (solvent-and-water-based) tested under the same heat flux of 50kW/m2. A correlation developed between the Cone Calorimeter data and ASTM E-84. Results of a large number of water and solvent-based FR coatings on wood were used to predict the performance and optimal thickness of several new FR formulations. Four systems were tested. Three different thicknesses of coatings were applied on Douglas Fir plywood specimens with dimensions of 10-by 1.9-cm. Bare Douglas Fire plywood specimens without any coating were tested.

12:30-1:30 pm **Lunch**

1:30 pm **Conference Adjourned**

EXHIBITS

(1) Fire Testing Technology: Fire/Smoke Test Instruments
Marcelo M. Hirschler (GBH International, Mill Valley, CA) and Stephen Upton (East Grinstead, UK.)
Fire Testing Technology (FTT), founded in 1989, manufactures the largest range of reaction-to-fire test instruments in the world, including the oxygen index, NBS and IMO smoke chambers, and cone calorimeter. FTT recently have added all the European regulatory requirement tests, including on: single burning item (SBI), ignitability, flooring radiant panel, noncombustibility, and the International Maritime Organization (IMO) smoke and flammability tests. Similarly, FTT is the world's exclusive manufacturer of the FM flammability apparatus, required for cleanroom materials. It provides a wide range of plastics and cable fir tests, for all of which it is the world's leading supplier. FT which owns the fire testing instrument trade mark, Stanto. Redcroft, provides supply, service, spares, maintenance contracts and technical support for all fire test instruments.

(2) Fire Instrumentation & Research Equipment Ltd.
J.P. Redfern, Rod Bell

Proceedings from:

THE 2000 ANNUAL CONFERENCE—RECENT ADVANCES IN FLAME RETARDANCY OF POLYMERIC MATERIALS

Business Communications Company, Inc.

The 2000 BCC Conference on the Flame Retardancy of Polymeric Materials was held in Stamford, CT in May 2000
The following papers were delivered:

New Directions in FR Technology: Reviews and Mechanisms—C/O Chemistry Studies under Different Conditions • Fiber-Optic Measurements of the Condensed Phase Spectra of Burning Polymers • Poly(Sodium Styrenesulfonate): A Self Intumescent Material • Ecological Aspects of Polymer Flame Retardation • An Investigation of Thermal Degradation of Polymer Flame Retardant Additives: Triphenylphosphine and Modified/Intercalated Trimethylphosphine • Determination of Thermal Barrier Properties of Fibre/Intumescent Textile Composite Systems • Flammability and Thermal Stability Studies of Polymer Layered-Silicate (Clay) Nanocomposites • **Inherent FR systems/System Performance**—Novel Flame-Retardant Polyurethanes • Quantitative Analysis of Volatile Products and Char Formation for Engineering Plastics • Role of Silicones in Flame-Retarded Polymer Systems • PA-6 Nanocomposite in Intumescent Formulations • The Flammability of Decorative Trimmings • **Important Trends in Halogenated FR Polymer Technology**—Flame Retardants for Enhanced Properties in Polyolefins • A Balanced View of the Halogen Controversy • Bromine/Chlorine Synergism • **Non-Halogen FR Polymer Technologies**—Melamine Flame Retardants: A Promising Future • Flame Retarding Polypropylene by a Novel System • New Flame Retarding Silicone Compound for Polycarbonate and Its Derivatives • Vitreous Fillers as a Smoke Suppressor in Intumescent Coatings • Metals as Synergists for Fire Retarded Polymers • Phosphorus-Based Fire Retardants in Epoxy Resins • New Test Results on Mechanisms and Performance of Molybdenum, Tin, and Zinc-Based Flame and Smoke Suppressants • New Developments with Phorphorus-Based Flame Retardants for the Plastics Industry • Maximizing Fire Test Performances of Polyolefins with Zinc Borate • New Aluminum Hydroxides for Printed Circuit Boards and Public Transport Applications • **Consumer/Focus, Industrial Applications**—Plenum Cable Fire Test: History, Implications • Flame-Retardant Fabrics and Composites Based on Natural Fibers for Upholstery and Interior Fittings • The Influence of Some Flame Retardants on the Flammability of Wood Studied by Cone Calorimeter • Synthesis and Evaluation of Amino Boronates Derived from Boric Acid for Fire and Decay Protection • CP{SC Fire Safety Activities Affecting FR Materials • **Testing, Standards and Environmental Issues**—The New European Test and Classification System for Reaction to Fire and Resistance to Fire • Tests for Flammability of Small Component Materials • Smoke Toxicity: Yields of Toxicants in Fires and Implications for Lethality and Incapacitation.

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U.S. CONSUMER PRODUCT SAFETY COMMISSION
RISK ASSESSMENT OF FR MATERIALS IN UPHOLSTERED FURNITURE[1]

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Abstract:

The U.S. Consumer Product Safety Commission (CPSC) is developing a possible flammability performance regulation for upholstered furniture. Residential fires in which upholstered furniture was the first item ignited account for more fire deaths than any other category of consumer products; total societal costs of furniture-related, unintentional-fire losses in 1998 were over $3.5 billion. As a part of the standards development process, the CPSC staff assessed potential health risks associated with the use of certain FR compounds that may be used in upholstery fabrics to meet a new standard. CPSC previously sponsored a study of potential FR chemical health risks by the National Academy of Sciences (NAS); the findings of the NAS study were submitted to Congress and CPSC in 2000. CPSC is also working with the National Institute of Occupational Safety & Health (NIOSH) to investigate potential worker health effects, and with the Environmental Protection Agency (EPA) to evaluate the need for other controls on FR fabric uses.

[1] The author prepared this paper as part of his official duties at the U.S. Consumer Product Safety Commission. The paper is in the public domain and may be freely excerpted or reproduced. The views expressed are the author's and do not necessarily represent the official position of the Commission.

Introduction

The U.S. Consumer Product Safety Commission (CPSC) was created in 1973 by an act of Congress (the Consumer Product Safety Act, 15 U.S.C. § 2051 *et seq.*) as an independent Federal regulatory agency with the primary mission to protect the public from unreasonable risks of product-related death and injury. CPSC has broad jurisdiction over household products, with specific exceptions such as tobacco products, medical devices, food and drugs, motor vehicles, firearms, and pesticides. The agency has three Commissioners, who collectively set policy and vote on matters of regulatory action, and a staff of about 500. CPSC's fiscal year 2001 budget is $52.4 million.

The Commission has undertaken numerous fire safety activities over the years that have contributed, along with other factors, to a decline in U.S. residential fire losses. These activities include mandatory fire safety standards for mattresses, matchbooks, carpets and rugs, cigarette and multi-purpose lighters, apparel and children's sleepwear, solid fuel heating equipment, and cellulose home insulation. CPSC has also supported numerous voluntary standard development efforts on almost every significant category of products associated with fire hazards.

Despite gradual reductions in residential fire losses over the past two decades, the risk to the public from fires involving consumer products remains high. In 1998, fire departments responded to an estimated 332,300 residential fires in the U.S. (excluding incendiary and suspicious fires). These fires caused an estimated 2,660 civilian deaths, over 15,200 injuries, and about $3.6 billion in property damage.

Ongoing standards development activities regarding upholstered furniture and mattresses and bedding may lead to increases in the use of FR materials. In the case of upholstered furniture, the CPSC staff has developed a draft flammability performance standard that would likely result in the use of FR materials.

Upholstered Furniture Flammability

Upholstered furniture fires are a leading cause of fire deaths among products under CPSC's jurisdiction. In 1998, these fires accounted for an estimated 520 deaths, 1,420 injuries and over $200 million in property damage (again, excluding losses from incendiary and suspicious fires). Smoking material-ignited furniture fires--virtually all involving cigarettes--accounted for most furniture fire losses (370 deaths in 1998). The other principal furniture fire risk involves ignition by open flames, predominantly small flame sources like lighters, matches and candles (100 total deaths in 1998). About two-thirds of small open flame-ignited fires involved childplay; about two-thirds of the fatalities were also children, mostly young children under age 5.

CPSC's furniture testing conducted over the past two decades shows a steady increase in cigarette resistance, attributable to the rising popularity of smolder-resistant polymeric materials such as thermoplastic fabrics and polyurethane foam fillings. The

cigarette ignition criteria of existing voluntary guidelines established by the Upholstered Furniture Action Council in 1978 encouraged the use of cigarette ignition-resistant materials and constructions. The vast majority of currently produced furniture is cigarette ignition-resistant.

Most furniture currently produced or in use will not, however, resist ignition from a small open flame. Smolder-resistant polymeric materials do not reduce open flame ignition propensity; in fact, many fire safety experts have expressed concern about the potential for polymerics, once ignited, to burn more rapidly and intensely, and to produce toxic combustion products. There is no nationwide standard in the U.S. addressing the open flame risk.

In 1993, the National Association of State Fire Marshals (NASFM) petitioned CPSC to initiate a regulatory proceeding to address all fire risks associated with upholstered furniture. NASFM suggested that CPSC adopt California or other existing standards. The Commission granted the petition in part, with respect to small open flame ignition, denied the petition with respect to large open flame ignition, and deferred action on cigarette ignition pending further evaluation of the level of cigarette ignition resistance among currently produced furniture.

Pursuant to the Commission's decision, the CPSC staff developed a draft small open flame performance standard. This draft standard contains two basic tests, for seating area composites (using a bench scale test method and seat/back cushion mockups) and for dust covers. In each test, a 35-millimeter butane flame (simulating a lighter or match) is applied for 20 seconds. The test sample must exhibit no continued flaming or other combustion for more than 2 minutes after removal of the test flame. Further, flaming may not extend beyond any edge of the test sample. The CPSC staff is considering an alternative to the seating area test; this alternative would allow the use of fire-resistive barriers to prevent fire growth. Under this possible alternative, manufacturers could choose to meet either the seating area test or the alternate barrier test. Such an alternative would probably be economically practical for certain higher-priced articles of furniture; these products comprise less than 5% of the current market.

In furniture mockup tests, fabrics appeared to be the most important determinant of flammability performance. Some FR fabrics that are widely used in the United Kingdom were observed to perform well in combination with non-FR polyurethane foam in the CPSC staff's tests. The CPSC staff also tested a variety of foam fillings, including FR foams used in California and the U.K.; the choice of foams had little effect on mockup ignition behavior.

FR Chemical Issues

The CPSC staff's draft standard specifies only performance criteria; it allows but does not require any particular approach to achieve compliance. Furniture and textile manufacturers have reported, however, that FR fabrics would likely be used to meet such

a standard. These may include fabrics with FR backcoatings, immersion or topical FR finishes, or inherently FR fibers.

The likelihood of FR use led CPSC to investigate whether FR treatments could pose risks to human health. In 1998, the Commission deferred regulatory action pending an evaluation of potential toxic health effects associated with possible consumer exposure to FR fabric treatments. CPSC held a two-day public hearing in May 1998 to gather additional information on human toxicity, ecotoxicity, and other risk-related issues.

The Fire Retardant Chemicals Association identified 16 chemical compounds or classes as the most likely candidates for use in fabrics to meet a small open flame standard. Some of these, including certain bromine- and phosphorus-based compounds, are currently used in upholstery fabrics, either in the U.K. or in other U.S. textile applications; none is used in U.S. residential furniture fabrics. The 16 compounds or classes are:

- Decabromodiphenyl oxide
- Hexabromocyclododecane
- Phosphonic acid, (3-{[hydroxymethyl]amino}-3-oxopropyl)-dimethyl ester
- Tetrakis (hydroxymethyl) phosphonium salts
- Zinc borate
- Alumina trihydrate
- Magnesium hydroxide
- Ammonium polyphosphates
- Antimony trioxide
- Tris (chloropropyl) phosphate
- Tris (1,3-dichloropropyl-2) phosphate
- Calcium and zinc molybdates
- Antimony pentoxide and antimonates
- Chlorinated paraffins
- Aromatic phosphate plasticizers
- Organic phosphonates

In response to the public hearing, toxicity and exposure data were provided on many of these compounds. The CPSC staff is using this information in its evaluation of potential FR chemical risks.

NAS Health Risk Study

In CPSC's fiscal year 1999 appropriation, Congress directed the agency to sponsor an independent, 12-month study of FR chemicals by the National Academy of Sciences' Committee on Toxicology. This study was to assess potential health risks associated with the use of FRs that might be used in upholstered furniture fabrics to meet a CPSC flammability standard. The Commission was prohibited from proposing any upholstered furniture regulation until it considered the NAS's conclusions.

To conduct the study, NAS selected a subcommittee of experts who reviewed all available toxicity and exposure data for the 16 identified chemicals or chemical classes. The subcommittee held three public meetings in 1999. The CPSC staff provided scientific data and documents to the subcommittee.

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

The final NAS report, "Toxicological Risks of Selected Flame Retardant Chemicals," was published in July 2000. The NAS report concluded that 8 of the 16 FR chemicals reviewed would present minimal risks, even under worst case assumptions about exposure. These were:

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

Additional exposure studies were recommended for the remaining 8 chemicals to determine the need for further toxicity studies:

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

Other Federal Agency Activities

To assist the Commission in its review of FR chemicals, the CPSC is coordinating with two other Federal agencies that have complementary expertise. The CPSC staff is working with staff at the National Institute for Occupational Safety and Health (NIOSH) to examine worker safety issues associated with FR fabric production and use. The CPSC staff is also working with staff at the Environmental Protection Agency (EPA) regarding the use of FRs in upholstered furniture fabrics. The work of these two agencies will help CPSC ensure that any proposed upholstered furniture flammability standard would not result in adverse health risks.

a. NIOSH

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

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

The NIOSH study is ongoing. In early 2001, NIOSH reported on their progress and preliminary conclusions from the HHE study. They generally found the potential for exposure, by either dermal or inhalation routes, to be low. They noted that workplace controls are already in place to minimize such exposures. NIOSH preliminarily concluded that increased FR usage in the quantities envisioned would not pose significant risks to workers involved in fabric finishing or handling. NIOSH will conduct further testing and evaluation to document this preliminary conclusion.

b. EPA

EPA is developing a possible Significant New Use Rule (SNUR) under the Toxic Substances Control Act (TSCA). A SNUR would require chemical companies to notify

EPA, at least 90 days in advance, of their intent to distribute existing FR chemicals for use in residential upholstered furniture fabrics. This would trigger a life-cycle environmental review encompassing manufacturing, use and disposal; EPA would consider industrial, occupational, residential, environmental, and general public exposures in determining the need for any subsequent action. Companies could be required to provide specific additional data (e.g., toxicity or exposure studies) for certain compounds. Additional controls could subsequently be imposed on the use of any FRs found to present unreasonable risks.

CPSC Staff Risk Assessment Approach

Under the Federal Hazardous Substances Act (FHSA, the legislation under which CPSC may regulate chemical risks associated with consumer products), whether a substance is "hazardous" depends not only on toxicity, but also on dose-response, exposure and risk. The CPSC staff evaluated potential FR chemical health effects by considering each of these elements. The staff conducted its evaluation in the context of the Commission's Chronic Hazard Guidelines, issued in 1992 under provisions of the FHSA.

a. Hazard Identification & Dose-Response Assessment

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

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

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

The toxicity reviews reflect the fact that many commercially useful chemicals -- even those with health or safety benefits — may, in large enough doses, be acutely or chronically toxic in humans. They do not present health risks, however, unless exposure occurs and the body is able to absorb sufficient quantities to produce the toxic effect. A good example of this is the use of alumina trihydrate and magnesium hydroxide in over-the-counter antacids; these are toxic at high doses, especially among patients with kidney disorders.

b. Exposure Assessment

The second part of the staff's analysis was to estimate potential exposure to FR chemicals from treated furniture fabrics. Much of the information used in this assessment was developed specifically for this project. Exposure data for these FR chemical fabric applications were generally limited because the applications did not exist; very few upholstery fabrics were available with any of the FR treatments of interest; most FR fabrics that were available came from sources outside the U.S.

From among the 16 potential-use chemical classes reported by the FRCA, the staff identified and selected for assessment 8 compounds that were already in use in furniture (e.g., in U.K. fabrics or California filling materials) or were reported by manufacturers as highly likely to be used in fabrics to meet a small open flame standard. It should be noted that these 8 compounds were not the same as either group of 8 ("minimal risk" or "further study") chemicals listed in the NAS report; the 8 compounds considered by the CPSC staff comprise some of each of these two groups.

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

Migration data were unavailable for some of the 8 FR chemicals considered; for these, the staff used data on compounds with similar properties to estimate exposure. In some cases, the staff made reasonable assumptions about skin absorption. Exposure routes and scenarios included the following:

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

The CPSC Laboratory conducted migration tests on samples of fabrics with 4 FR chemicals currently in use in the U.K.: antimony trioxide (AT), decabromodiphenyl oxide (DBDPO), hexabromocyclododecane (HBCD), and phosphonic acid (PA). Migration tests were also conducted on fabric samples containing a fifth chemical, tetrakis hydroxymethyl phosphonium chloride (THPC), currently used in apparel fabrics and considered a candidate for cotton upholstery fabrics. The laboratory staff developed methods for chemical migration from upholstery fabrics. The staff also estimated exposure, using surrogate compounds, for 3 additional chemicals used in related applications (textiles or foam fillings): cyclic phosphonate ester (CPE, one of the compounds in the organic phosphonates class), 2-ethylhexyl diphenyl phosphate (EHDP, one of the aromatic phosphate plasticizers), and tris (1,3-dichloropropyl) phosphate (TDCP).

The staff obtained samples of the 5 available FR-treated fabrics, and measured the amounts of FR chemicals that migrated from the fabrics into liquids under various conditions. Other experiments simulated the mouthing action of young children. The staff also studied the effect on migration of exposing fabrics to environmental conditions such as wear, filtered sunlight and heat. In general, the staff found migration to be low for these compounds; for several parameters, some or all of the migration measurements were below the limit of detection. In the case of THPC (a reactive chemical), migration of phosphorus-containing compounds was greater than expected, but the chemical form that was released was unknown.

To ascertain the dermal bioavailability of FR compounds, CPSC worked with the U.S. Environmental Protection Agency's National Health Effects and Environmental Research Laboratory (NHEERL) to conduct a percutaneous absorption study. This study

measured the amount of DBDPO, HBCD and TDCP absorbed by the skin of laboratory animals.

c. Risk Assessment Method

Using the data on hazard assessment and dose-response from the toxicity reviews, and data from the exposure studies, the staff evaluated the risks to consumers associated with the use of 8 candidate FR chemicals either most likely to be used or of greatest concern. Combined risks associated with 4 different exposure scenarios were considered for each chemical.

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

The CPSC staff calculated a hazard index (HI) for non-cancer hazards for each of these chemicals. The staff also calculated lifetime cancer risks for antimony trioxide (AT, inhalation only) and TDCP.

Based on the available scientific data for the most likely FR chemical candidates, the staff concludes that a number of existing FR chemicals could be used in upholstered furniture cover fabric or barrier treatments with negligible health risks to consumers. The staff generally agrees with the findings of the NAS study on this issue. Additional data are needed, however, regarding:

a. potential airborne levels of antimony trioxide (AT) that may be released from treated furniture fabrics (to supplement the CPSC staff's conclusions, which were based on mathematical modeling); and
b. the chemical composition and toxicity of extractants from fabrics treated with tetrakis (THPC); these may be THPC polymers or phosphine oxide (THPO), but could not be clearly identified in CPSC's laboratory analyses.

Data on these issues are needed to complete the assessment of these two chemicals. The NAS report listed THPC among the "minimal risk" FR chemicals, based on an assumption that only a small amount of THPC would be released from fabrics. The CPSC staff is working with producers of AT and THPC to obtain the additional data necessary to complete the assessment of these chemicals.

For More Information

Information on various CPSC activities is available on the agency's Internet web site, www.cpsc.gov. This includes the latest (October 1997) staff briefing package on upholstered furniture flammability. A new briefing package, summarizing the CPSC staff's FR chemical risk assessment and other technical information, is expected to be available to the public in 2001. CPSC documents and information are also available from CPSC's Office of the Secretary (telephone 301-504-0800, fax 301-504-0127) or through the Commission's toll-free Hotline at 1-800-638-CPSC.

U.S. Consumer Product Safety Commission
Risk Assessment of FR Materials in Upholstered Furniture

BCC Conference on Flame Retardancy
May 22, 2001

1998 Residential Fire Losses

- 332,300 fires
- 2,660 civilian deaths
- 15,260 injuries
- $3.6 billion property damage

- Total societal costs ~ $20 billion
  (excluding incendiary & suspicious fires)
- Total losses declining but still high

1998 National Fire Loss Estimates for Upholstered Furniture

IGNITION SOURCE	FIRES	DEATHS	INJURIES	PROPERTY LOSS $Mil.
ALL SOURCES	10,200	520	1,420	$ 207
SMOKING MATERIALS	4,900	370	760	$ 91
OPEN FLAMES	1,900	100	410	$ 41

Total Societal Cost = $3.5 billion

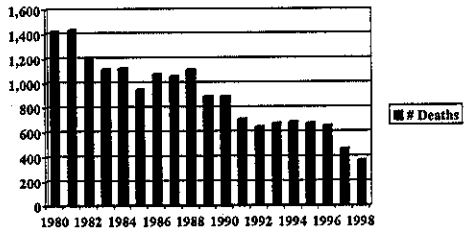
Most open flame losses from childplay fires

(excludes incendiary & suspicious fires)

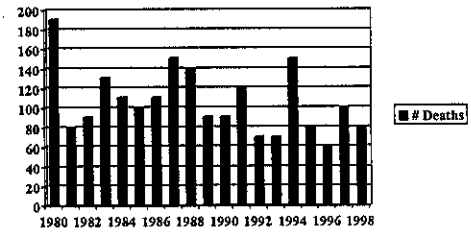
Upholstered Furniture: Activity Overview

- NASFM Petition
- ANPR - Small Open Flame
- Standards Development & Analysis
- FR Chemicals / NAS
- Regulatory Procedures / GAO
- NASFM Polyurethane Foam Petition
- Decision Briefing Package 2001

Upholstered Furniture Fire Deaths: Cigarette Ignition 1980-1998



Upholstered Furniture Fire Deaths: Small Open Flame 1980-1998



CPSC Staff Draft Standard

- Primary Goal: limit ignition / early fire growth
- Seating Area Test
  - Mockup; 20 sec. flame; 2 / 15 min. combustion
- Option under consideration:
  Alternate Seating/Barrier Test
  - Mockup; UK crib #5; 10 / 60 min. combustion
- Dust Cover Test
  - Component; 20 sec. Flame; 2 / 15 min. combustion

Materials to Meet CPSC Draft Small Open Flame Std.

- FR fabric backcoatings
- FR fabric immersion treatments/ surface finishes
- FR fiber fabrics
- FR barriers / laminates

Chemical Hazard Issues

- CPSC evaluation guided by FHSA
- "Hazardous substances"
  - Must be toxic
  - Must pose potential substantial illness or injury from reasonably foreseeable use
- Toxicity, exposure, bioavailability

FR Chemical Evaluation

- CPSC public hearing
- NAS study
- NIOSH worker study
- EPA new use rule
- CPSC staff risk assessment

NAS Conclusions

- Report to Congress 4/00
- 8 FR chemicals - minimal health risk, even under extreme exposure
- 8 FR chemicals - further exposure data needed

"Minimal Risk" FRs

- Decabromodiphenyl Oxide
- Hexabromocyclododecane
- Phosphonic Acid
- Tetrakis Hydroxymethyl Hydronium Salts
- Zinc Borate
- Alumina Trihydrate
- Magnesium Hydroxide
- Ammonium Polyphosphates

"Further Exposure Study" FRs

- Antimony Trioxide
- Tris (2-chloropropyl) Phosphate
- Tris (1,3-dichloropropyl-2) Phosphate
- Calcium & Zinc Molybdates
- Antimonates
- Chlorinated Paraffins
- Aromatic Phosphate Plasticizers
- Organic Phosphonates

Other Federal Agency Activities

- **NIOSH - Worker HHE Study**
  - **Sampling & analytical methods**
  - **Plant inspections**
- **EPA - Possible SNUR**
  - **Pre-manufacturing notification**
  - **Life-cycle environmental review**

CPSC Staff Risk Assessment

- **Toxicity / Dose-Response**
- **Exposure Assessment**
  - **Dermal, oral, inhalation routes**
  - **Migration data**
  - **Skin absorption study**
- **Risk Assessment**
  - **4 exposure scenarios**
  - **Hazard Index (non-cancer)**
  - **Lifetime cancer risks**

Preliminary Conclusions

- **Some existing FR's acceptable**
  - **Negligible risk to consumers**
- **Additional data needed for:**
  - **Antimony trioxide (AT) - inhalation**
  - **Tetrakis (THPC) - identity & toxicity of extractants**

CPSC Briefing Package

- **Options: Small Open Flame Ignition**
  - **Draft standard**
  - **Regulatory analysis / Reg. Flex. Analysis**
  - **FR chemical risk / Environmental assessment**
  - **Voluntary alternatives; Cal TB-117 activities**
- **Cigarette Ignition**
- **PUF Labeling Petition**

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