Flame Retardants in Buildings, Toxicity, and Implications for Occupant Health

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Green Science Policy Institute

for more information visit
www.greensciencepolicy.org

THE PROBLEM:

Most Chemicals Are NOT Effectively Regulated in the U.S.

- The U.S. Toxic Substances Control Act (1976)
- 62,000 chemicals in commerce “grandfathered”
- 20,000 new chemicals have been introduced
  - 85% have no health data
  - 67% no data at all

Michael Wilson, Green Chemistry in California: http://coeh.berkeley.edu/news/06_wilson_policy.htm

Chemicals of High Concern:

- VOCs (volatile organic compounds)
  formaldehyde, benzene, and toluene
- Metals
  - lead, mercury, cadmium, arsenic, and chromium
- **SVOCs** (semi-volatile organic compounds)
  - Flame retardants, stain repellents, etc
  - Carbon bonded to bromine, chlorine, fluorine
- Endocrine disruptors
  - Phthalates, BPA

Organohalogen Pesticides and Flame Retardants
(Carbon bound to Bromine, Chlorine)

Halogenated Pesticides

- mostly banned as Persistent Bioaccumulative Toxins (PBTs)
  - DDT, Mirex, Dieldrin, Aldrin,, etc.
- decreasing levels in food

Halogenated Flame Retardants

- still in common use
- similar to pesticides
  - Dechlorane flame retardant is Mirex
- pounds in home furniture and insulation
- increasing levels in food

Brominated Tris Flame Retardant

Tris (2,3-dibromopropyl) phosphate

- Used to treat U.S. children's sleepwear from 1975 to 1977
- Up to 10% of the weight of fabric
- Not covalently bonded to fabric
- Absorbed in children's bodies; metabolite found in their urine
- Mutagen and possible carcinogen

Science, January 7, 1977

Flame-Retardant Additives as Possible Cancer Hazards

The main flame retardant in children's pajamas is a mutagen and should not be used.

Arlene Blum and Bruce N. Ames

Thousands of chemicals to which humans have been exposed have been introduced into the environment without adequate toxicological testing.

Some chemical flame retardants provide a good example of a technological innovation where adverse environmental effects may outweigh some of the benefits.

Until recently, little attention was paid to the long-term biological effects of these flame-retardant compounds. The main organic chemicals used in flame retardants contain bromine or chlorine or they are phosphate esters. Some have chemical structures (discussed below) that are closely related to compounds known to cause cancer or to be toxic to animals. Several compounds previously used as flame retardants have been shown to be teratogenic, carcinogenic, mutagenic, or highly toxic (*4*).

Brominated Tris Flame Retardant

Tris (2,3-dibromopropyl) phosphate

CPSC Bans TRIS-Treated Children's Garments

April 7, 1977

Chlorinated Tris (TDCPP) replaced Brominated Tris

- removed from children's PJ's in 1977
- used today in baby products, furniture, etc.

Which Building Insulation Use Flame Retardants?

- Batt Insulation
  (Glass and Mineral Wool)
- Board Insulation
  (Polyurethane, Polyisocyanurate, Polystyrene)

- Blown-in Insulation
  (Cellulose, Fiberglass)

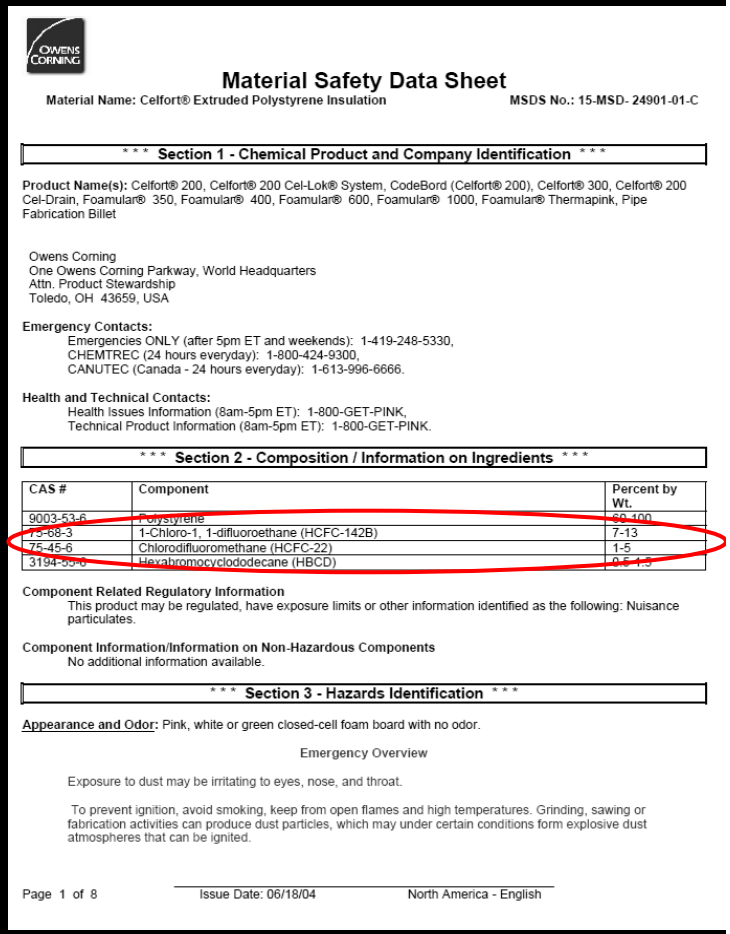
- Poured-in Insulation
  (Perlite, Vermiculite)

- Foamed-in Insulation
  (Polyurethane, Polyisocyanurate, Polyicynene)

All Polystyrenes Contain HBCD

Hexabromocyclododecane

- On first EU list of 13 “Substances of Very High Concern”.
- Proposed as a POP under the Stockholm Convention
- Global contaminant
- Found in household dust, breast milk, sewage sludge, wildlife
- Disrupts thyroid hormones
- Reproductive toxicant
- Developmentally neurotoxic



Material Safety Data Sheet

Material Name: Celfort® Extruded Polystyrene Insulation **MSDS No.: 15-MSD- 24901-01-C**

*** * * Section 1 - Chemical Product and Company Identification * * ***

Product Name(s): Celfort® 200, Celfort® 200 Cel-Lok® System, CodeBord (Celfort® 200), Celfort® 300, Celfort® 200 Cel-Drain, Foamular® 350, Foamular® 400, Foamular® 600, Foamular® 1000, Foamular® Thermapink, Pipe Fabrication Billet

Owens Corning
One Owens Corning Parkway, World Headquarters
Attn. Product Stewardship
Toledo, OH 43659, USA

Emergency Contacts:
Emergencies ONLY (after 5pm ET and weekends): 1-419-248-5330,
CHEMTREC (24 hours everyday): 1-800-424-9300,
CANUTEC (Canada - 24 hours everyday): 1-613-996-6666.

Health and Technical Contacts:
Health Issues Information (8am-5pm ET): 1-800-GET-PINK,
Technical Product Information (8am-5pm ET): 1-800-GET-PINK.

*** * * Section 2 - Composition / Information on Ingredients * * ***

CAS #	Component	Percent by Wt.
9003-53-6	Polystyrene	60-100
75-68-3	1-Chloro-1, 1-difluoroethane (HCFC-142B)	7-13
75-45-6	Chlorodifluoromethane (HCFC-22)	1-5
3194-55-6	Hexabromocyclododecane (HBCD)	0.5-1.5

Component Related Regulatory Information
This product may be regulated, have exposure limits or other information identified as the following: Nuisance particulates.

Component Information/Information on Non-Hazardous Components
No additional information available.

*** * * Section 3 - Hazards Identification * * ***

Appearance and Odor: Pink, white or green closed-cell foam board with no odor.

Emergency Overview

Exposure to dust may be irritating to eyes, nose, and throat.

To prevent ignition, avoid smoking, keep from open flames and high temperatures. Grinding, sawing or fabrication activities can produce dust particles, which may under certain conditions form explosive dust atmospheres that can be ignited.

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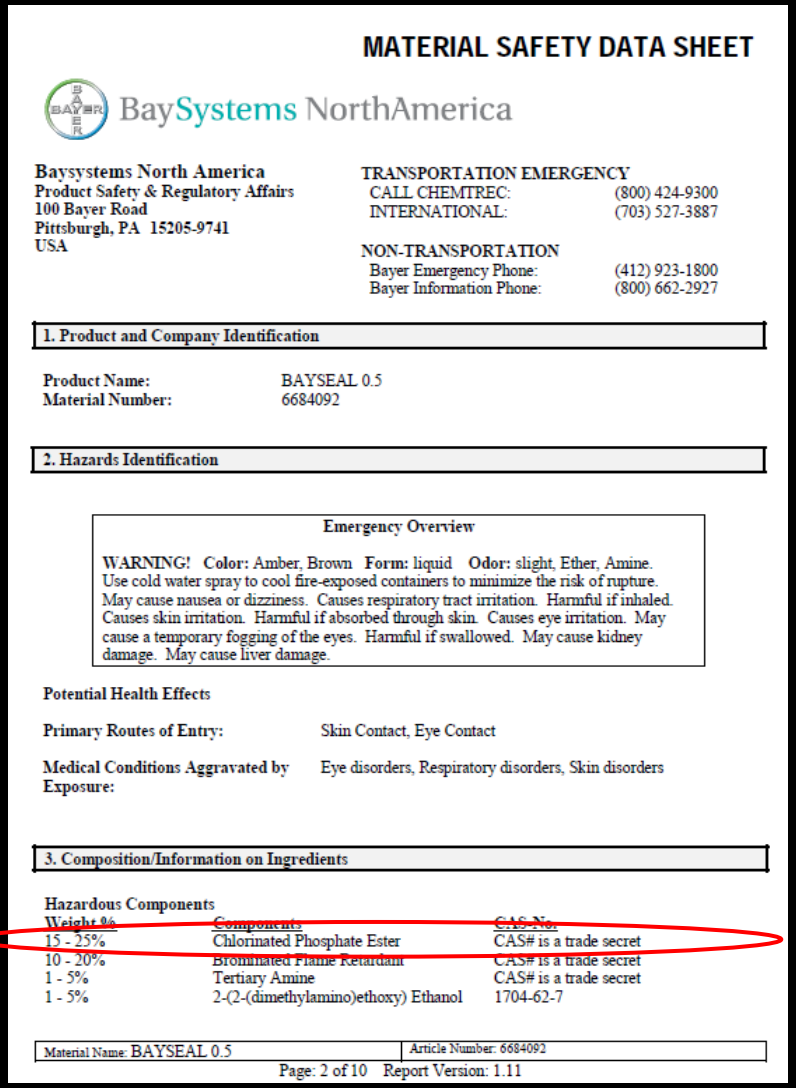
Polyurethane & Polyisocyanurate

- can contain halogenated flame retardants and blowing agents
- either known toxicants or similar in structure and lacking health information

15 -25% Chlorinated phosphate ester

10 -20% Brominated flame retardant



MATERIAL SAFETY DATA SHEET

BaySystems NorthAmerica

Baysystems North America
Product Safety & Regulatory Affairs
100 Bayer Road
Pittsburgh, PA 15205-9741
USA

TRANSPORTATION EMERGENCY
CALL CHEMTREC: (800) 424-9300
INTERNATIONAL: (703) 527-3887

NON-TRANSPORTATION
Bayer Emergency Phone: (412) 923-1800
Bayer Information Phone: (800) 662-2927

1. Product and Company Identification

Product Name: BAYSEAL 0.5
Material Number: 6684092

2. Hazards Identification

Emergency Overview

WARNING! Color: Amber, Brown **Form:** liquid **Odor:** slight, Ether, Amine. Use cold water spray to cool fire-exposed containers to minimize the risk of rupture. May cause nausea or dizziness. Causes respiratory tract irritation. Harmful if inhaled. Causes skin irritation. Harmful if absorbed through skin. Causes eye irritation. May cause a temporary fogging of the eyes. Harmful if swallowed. May cause kidney damage. May cause liver damage.

Potential Health Effects

Primary Routes of Entry: Skin Contact, Eye Contact

Medical Conditions Aggravated by Exposure: Eye disorders, Respiratory disorders, Skin disorders

3. Composition/Information on Ingredients

Hazardous Components

Weight %	Components	CAS-No.
15 - 25%	Chlorinated Phosphate Ester	CAS# is a trade secret
10 - 20%	Brominated Flame Retardant	CAS# is a trade secret
1 - 5%	Tertiary Amine	CAS# is a trade secret
1 - 5%	2-(2-(dimethylamino)ethoxy) Ethanol	1704-62-7

Material Name: BAYSEAL 0.5 | Article Number: 6684092
Page: 2 of 10 Report Version: 1.11

RIGID INSULATIONS

	Product	Primary Form	Cost / sq.ft. / R (materials & labor)	Thermal resistance (R-value per inch)	Raw Materials	Known Health Issues	Fire Retardant	Water Resistant	Embodied Energy
CONTAINS HFR	Extruded Polystyrene (XPS)	Board	$$	5.0	Refined Petroleum + blowing agent (HCFC); up to 15% recycled content	CO in Smoke, Carcinogenic Fire Retardants, benzene	0.7% HBCD	Yes	High
	Expanded Polystyrene (EPS)	Board	$$	3.85	Refined Petroleum + blowing agent (pentane); up to 60% recycled content	CO in Smoke, Carcinogenic Fire Retardants, benzene	2.5% HBCD	Yes	High
	Polyisocyanurate	Board	$$	6.5	Refined Petroleum + blowing agent (pentane); up to 10% recycled content	CO in Smoke, Toxic Fire Retardants	5-10% TCPP	Yes	High
	Polyurethane	Foamed-on	$$	3.6-5.0	Refined Petroleum + blowing agent (HFC); up to 25% soy oil replacement	Toxic during installation, CO in Smoke	? % TCPP	Yes	High
DOES NOT CONTAIN HFR	Perlite	Board	$	2.7	perlite, cellulose binders, and waterproofing agents	No known issues	NA	Yes	Low
	Mineral Wool (AKA Rockwool)	Board	$$	4.2	Slag wool fiber and/or basaltic rock, phenolic resin	Can irritate and congest lungs during installation	NA	Yes	Low (waste product)
	Cellular Glass Foam	Board	$$$	3.45	Alumino-silicate cellular glass with a specially elaborated composition; totally inorganic; contains no binders	No known issues	NA	Yes	High
	Aerogel	Board	$$$	10.0	Silica gel, PET, fiberglass	Can irritate and congest lungs during installation	NA	Yes	High
	Carbon Foam	Board	$$$	6.67	Calcined Coke		NA	Yes	Low (waste product)
	Agrifiber	Board	$$	3.0	Rice hulls, mycelium roots, wheat or rice straw	No known issues	Borate	No	Low
	Cementitious Foam	Foamed-on	$$	3.9	Modified Oxychloride Cement	No known issues	NA	Yes	High
	Cellulose	Blown-In	$	3.5	Shredded Newspaper	No known issues	Sodium Borate	No	Low (waste

Mineral Wool (Rockwool)

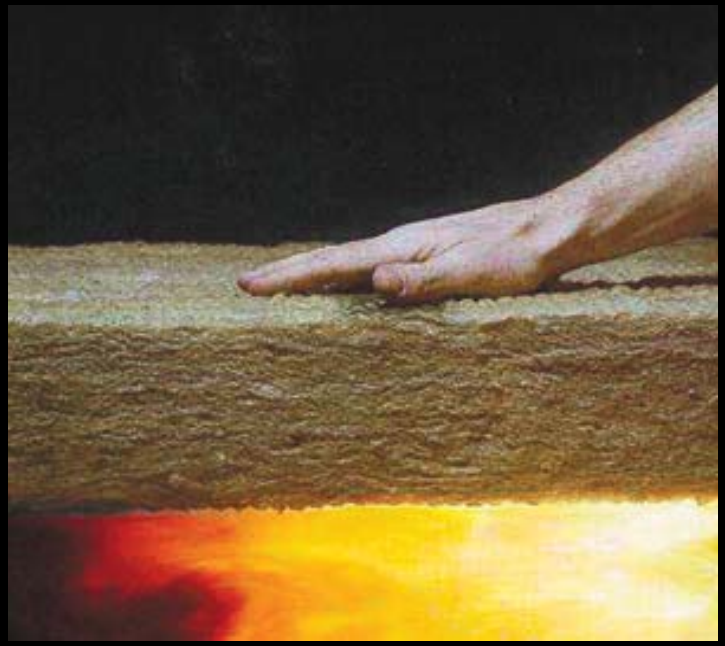
Primary Form	Cost / sq.ft. / R (materials & labor)	Thermal resistance (R-value per inch)	Raw Materials	Known Health Issues	Fire Retardant	Water Resistant	Embodied Energy
Board	$$	4.2	Slag wool fiber and/or basaltic rock, phenolic resin	Can irritate and congest lungs during installation	NA	Yes	Low (waste product)

TYPICAL SIZES & USES

- Underslab, roofs, rainscreen
- 1”-6”TH, 16”/24”/36”W, 48”/60”L panels

EXAMPLE MANUFACTURERS

- Thermafiber Rainbarrier (thermafiber.com)
- Roxul Board Insulation (www.roxul.com)



Should HBCD be used when there is not a fire hazard?

- Is a FR needed below grade, eg between cement slab and soil?
- Can HBCD be replaced with a non-toxic chemical when a flame retardant is needed?

CALIFORNIA FURNITURE FLAMMABILITY STANDARDS

- TB 116:

  Voluntary standard for fabric of upholstered furniture

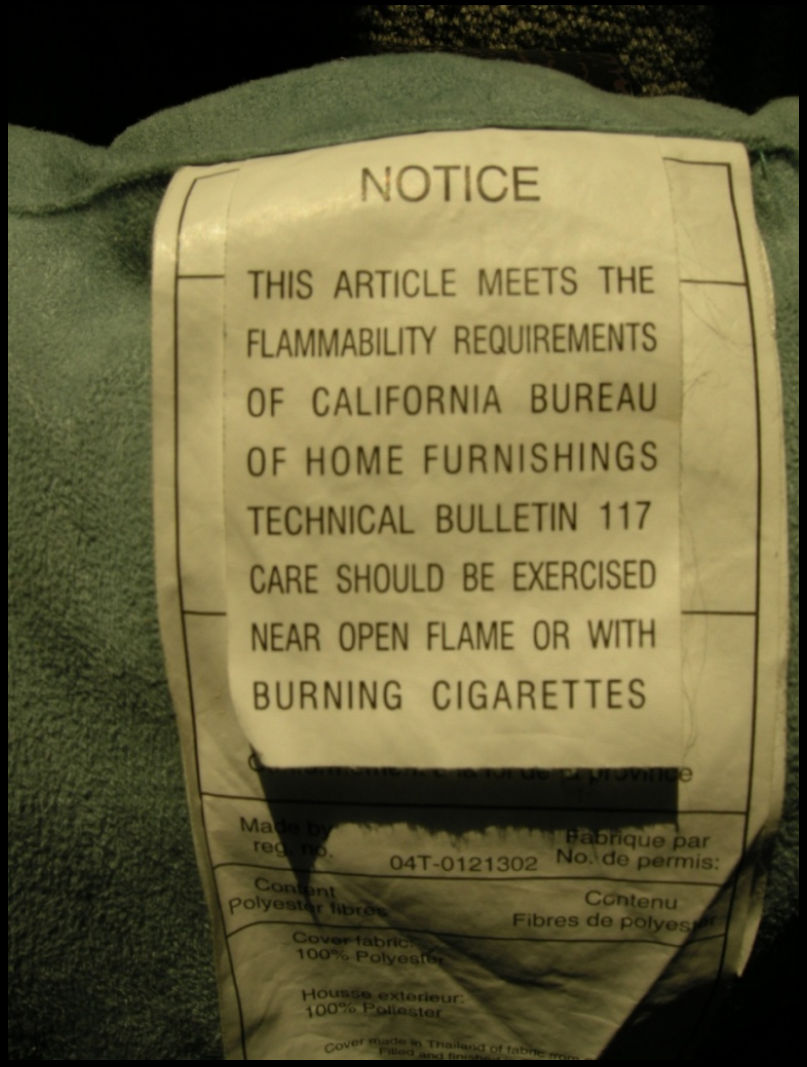
- TB 117:

  Twelve second open flame and smolder standard for filling materials used in upholstered furniture.

- TB 133:

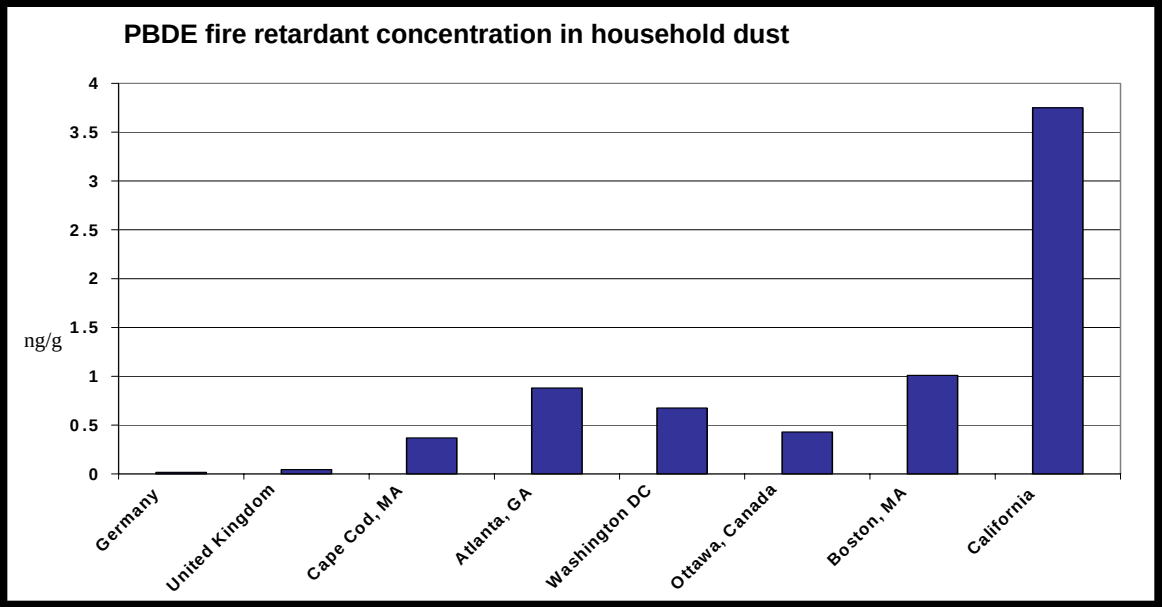
  Severe flammability test procedure for composite testing of seating furniture for use in public occupancies

TB117 furniture & baby products contain flame retardants



HUMAN EXPOSURE

- Flame retardants migrate into house dust
  - Stapleton, H. M., J. G. Allen, S. M. Kelly, A. Konstantinov, S. Klosterhaus, D. Watkins, M. D. McClean, and T. F. Webster. 2008. Alternate and new brominated flame retardants detected in U.S. house dust. Environ Sci Technol 42 (18): 6910-6.
- Toddlers have three times the levels of pentaBDE of their mothers
  - http://www.ewg.org/reports/pbdesintoddlers
- Californians have higher levels in their house dust and body fluids than residents of other states
  - Kellyn S. Betts, Environmental Health Perspectives 116, A202 - 208, 2008



Source: Elevated House Dust and Serum Concentrations of PBDEs in California: Unintended Consequences of Furniture Flammability Standards? Zota, Ami R., Rudel, Ruthann A., Morello-Frosch, Rachel A., and Brody, Julia Green, Environ. Sci. Technol., 2008, 10.1021/es801792z

ANIMAL HEALTH

Can cause adverse health impacts in animal studies**:**

- **Reproductive**: Abnormal gonadal development, reduced ovarian follicles, reduced sperm count
- **Neurological**: Decreased memory, learning deficits, altered motor behavior, hyperactivity
- Interference with **thyroid hormone action,**
- **Endocrine disorders,** contributing to obesity & diabetes
- **Cancer**

HUMAN HEALTH

- **Cryptorchidism**
  - Main et al, 2007
- **Reproductive Hormone Effects**
  - Meeker et al., 2009 – Decrease in Androgens and LH; Increase in FSH and Inhibin
  - Meijer et al, 2008 Decrease in Testosterone
- **Reproductive Effects**
  - -- Eskenazi et al., 2009 Low Birth Weight; Altered Behaviors
  - -- Harley et al, 2010

    Increased time to pregnancy

Neurological Effects

- Herbstman et al, 2010 Decreased IQ

Decreased Sperm Quality

- Akutse et al, 2008

Diabetes

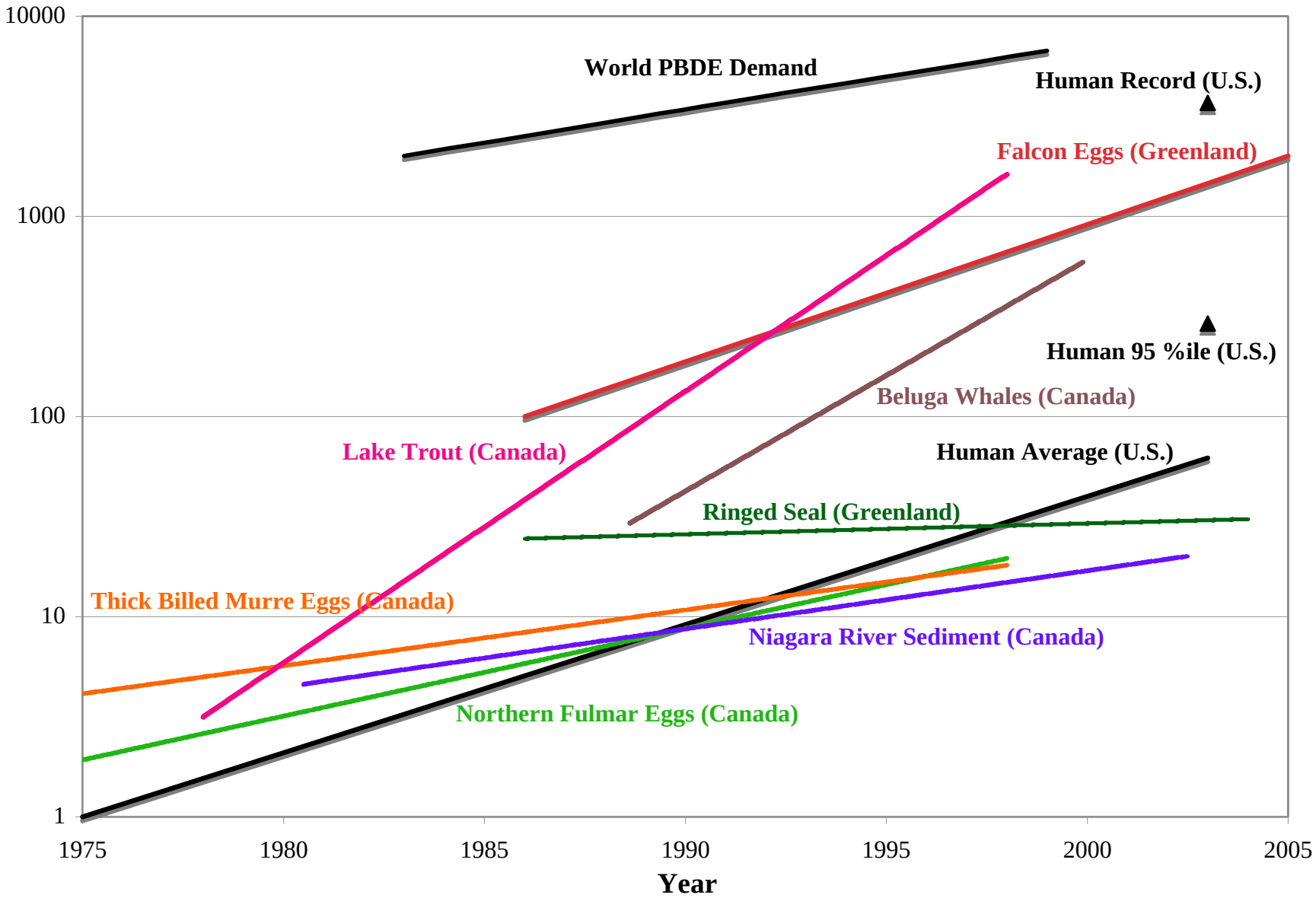
- Lim et al, 2008
- Turyk et al, 2009 (only in hypothyroid subjects)

Thyroid Homeostasis

- Herbstman et al, 2008 – decrease in TT4
- Turyk et al, 2007 – elevated T4
- Meeker et al, 2009 – elevated T4, TBG
- Dallaire et al, 2009 -Elevated T3 ~BDE47
- Eskenzai et al, 2009 – Low TSH

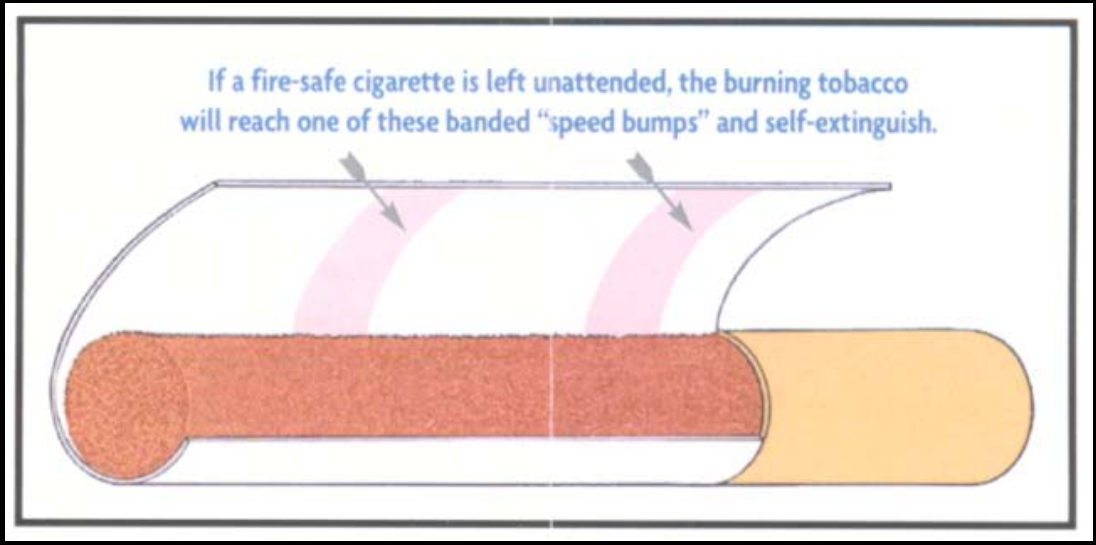
Courtesy, Linda S. Birnbaum, Director, NIEHS and NTP

Where should all the flame retarded furniture go?


10000
1000
100
10
1
1975
1980
1985
1990
1995
2000
2005
Year
World PBDE Demand
Human Record (U.S.)
Falcon Eggs (Greenland)
Human 95 %ile (U.S.)
Beluga Whales (Canada)
Lake Trout (Canada)
Human Average (U.S.)
Ringed Seal (Greenland)
Thick Billed Murre Eggs (Canada)
Niagara River Sediment (Canada)
Northern Fulmar Eggs (Canada)

Fire deaths in the US are declining due to:

- 50% decrease in cigarette consumption since 1980
- Enforcement of improved building, fire and electrical codes
- Increased use of sprinklers and smoke detectors
- Introduction of fire-safe cigarettes and candles
- Use of flame retardant chemicals?



Does TB117 provide a fire safety benefit?

Does it protect foam from ignition?

– once fabric burns, underlying foam is presented with flame challenge which is many times larger than the flame which originally ignited the fabric

– TB117 foam made no significant, consistent difference in either ignition or flame spread

Talley, T. H., Phases 1&2, UFAC Small Open Flame Tests and Cigarette Ignition Tests, *Annual AFMA Flammability Conf.* (1995).

Halogenated Flame Retardants and Fire Toxicity

	No FR	Treated with chlorinated tris	With Penta-BDE
Time to Sustained Ignition (seconds)	**16**	**18**	**19**
Peak Heat Release Rate (kW/m^2)	**412**	**326**	**259**
Smoke (m^2/kg)	**413**	**745**	**833**
Carbon Monoxide (kg/kg)	**0.02**	**0.08**	**0.13**
Soot (kg/kg)	**0.01**	**0.10**	**0.88**

Chandra Jayakody, Dan Myers, Usman Sorathia, and Gordon L. Nelson. "Fire-Retardant Characteristics of Water-Blown Molded Flexible Polyurethane Foam Materials“
J. Fire Sciences, Vol. 18, pp 430-455, 2000.

Bed coverings

California TB 604

Open Flame standard for comforters,

mattress pads and pillows

No health information needed for chemicals or materials

TB 604 suspended!

Baby Products?

Graco baby stroller with 3% TDCP or chlorinated Tris in the foam in the padding.

“Brestfriend” nursing pillow with Antiblaze V6, 37% chlorine
2,2-Bis(Chloromethyl) Trimethylene Bis(Bis(2-Chloroethyl) Phosphate).

California Senate Bill 772 would stop a defacto requirement for flame retardants in the foam in baby products which have no fire hazard.

100 baby products being analyzed

Recommendations

- Use alternative insulation materials rather than polystyrene which always contains HBCD
- Use non-halogenated flame retardants with polyurethane and polyiso
- Only use flame retardants with a proven fire safety benefit
- Polystyrene without HBCD for uses without fire hazard
- Work for improved flammability codes and standards that can be met without added chemicals

Support Chemical Reform

The Safe Chemicals Act 2010 (S. 3209)

- Sen. Frank Lautenberg

The Toxic Chemical Safety Act (HF. 5820)

- Rep. Bobby Rush, Rep. Henry Waxman

- Basic Information for Chemicals Provided by Manufacturers
- Prioritize Chemicals of High Concern such as Halogenated Flame Retardants
- Reform Confidential Business Information


For more information, please sign our mailing list
info@greensciencepolicy.com
www.greensciencepolicy.org