Flame Retardants in Furniture & Electronics: A Lifecycle Approach

,

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for more information visit
www.greensciencepolicy.org

Life-Cycle of Flame Retardants

Manufacturing

In Use

Recycling

End of Life

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

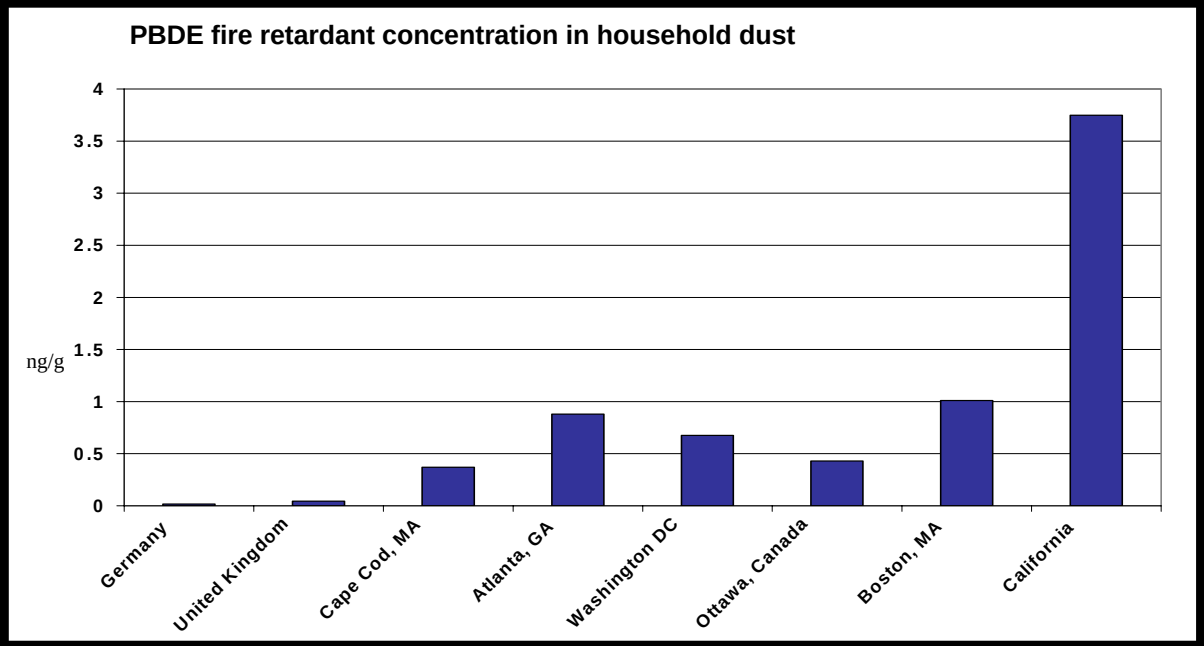
Halogenated Flame Retardants

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

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)

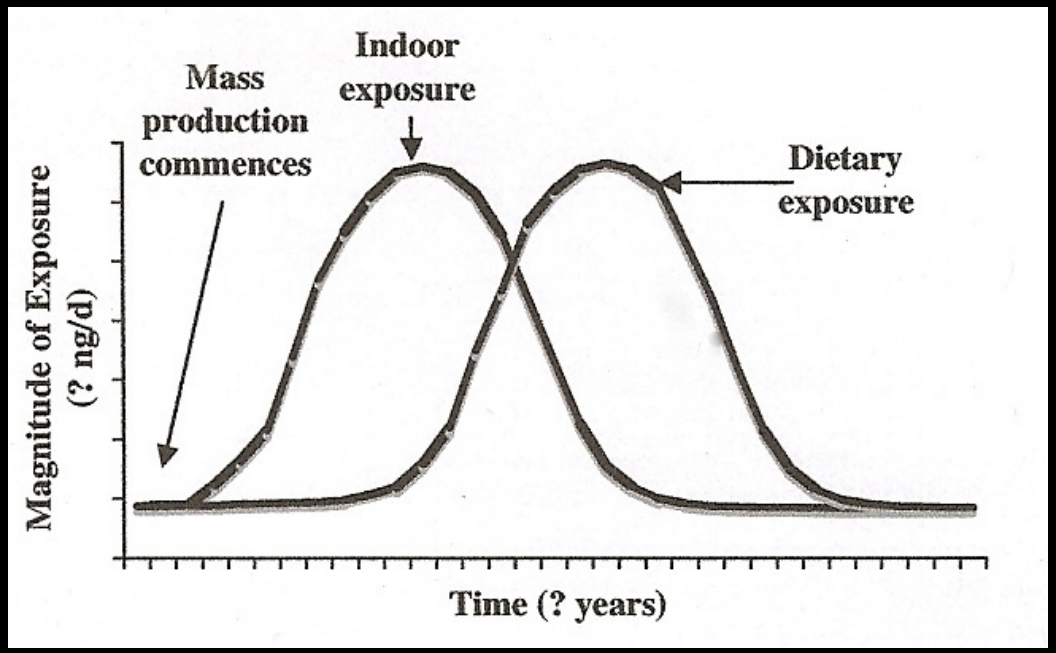
Thyroid Homeostasis

- 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

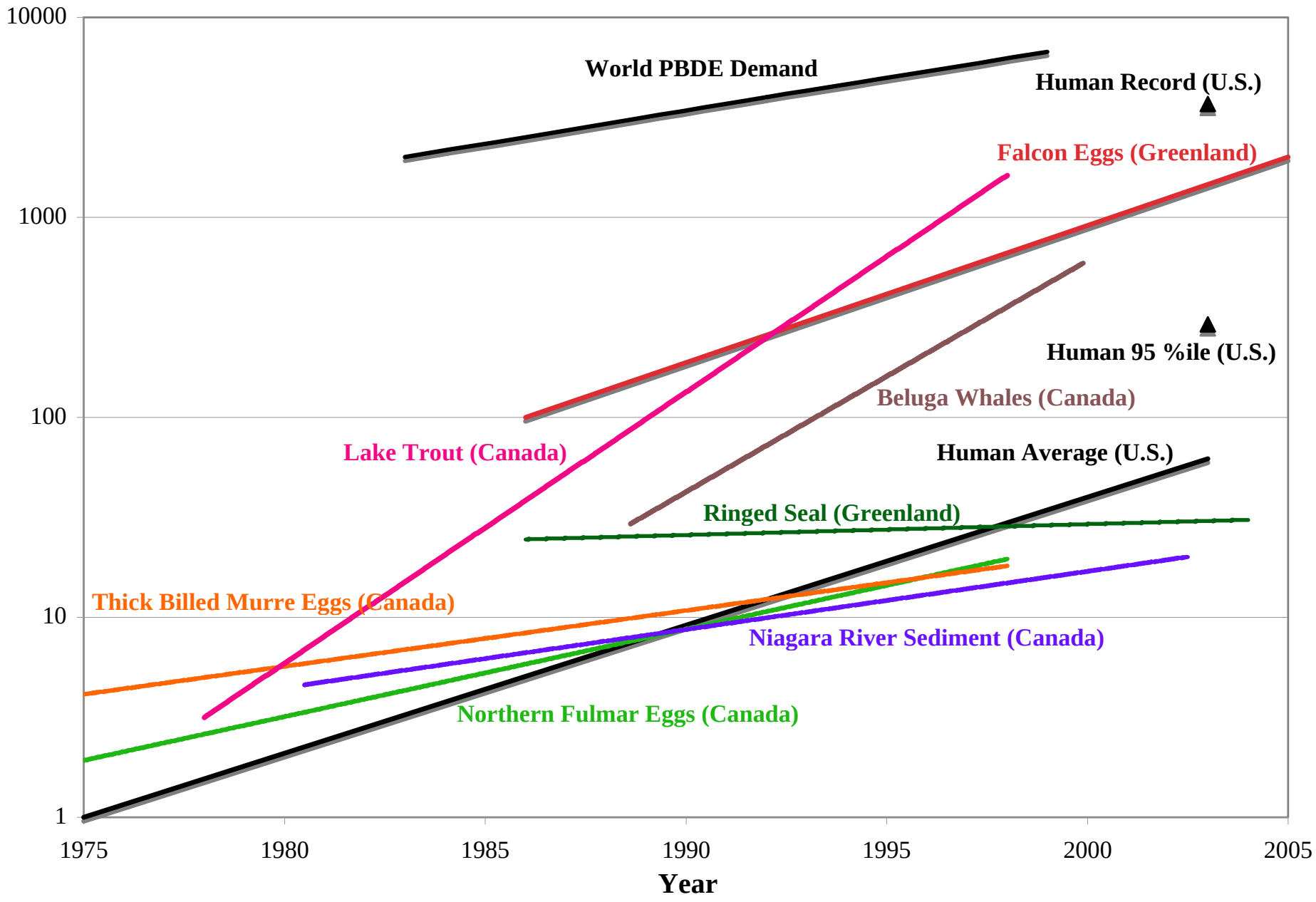
Where should all the flame retarded furniture go?

The Flame Retardant "Time Bomb"



- PentaBDE: 80% indoor air and dust, 20% diet.
- Penta is "bleeding" into the outdoor environment.
- Owing to its persistence, it will amplify in food chains.
- Critical needs: (a) reduce the existing indoor reservoir
  (b) manage the end-of-life

Harrad and Diamond, Exposure to to PBDEs and PCBs: current and future scenarios, 2006 Atmospheric Environment


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)

Photo, courtesy Myrto Petreas

All landfills will fail, whether they are lined or not, because the geomembrane layer will lose its characteristics and leaching will occur.

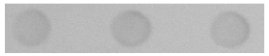
based on Monica N. Danon-Schaffer, Ph.D. Thesis. UBC, 2010

How can we?

Capture indoor reservoir and manage end of life

Step 1: Identify

Table 4. Blind test with PHAIA and dipstick format

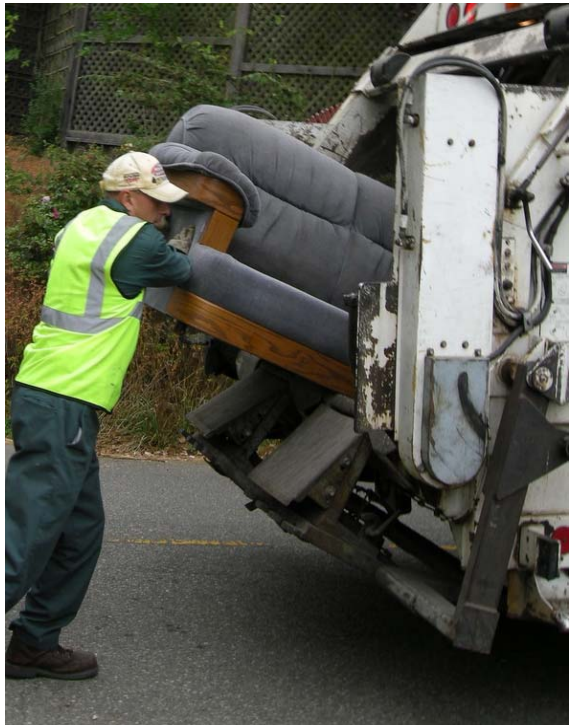
Sample	Detected by PHAIA (%, w/w)	[b]Dipstick assay
#007	[a]ND	
#008	0.58	
#009	ND	
#010	0.98	
#011	1.0	
4B	ND	

[a]Not detected. [b]Protein A purified BDE-47 PAb was immobilized on nitrocellulose membrane at the amount of 1.0, 0.5, and 0.3 μg per spot from left. The assay methods are as described in the method section.

Dipstick immunoassay for BDE-47 developed by Hee-Joo Kim, Bruce Hammock and team.

(can perform the assay with BDE-47 antibody and novel reagent phage peptide within 1 hour after simple extraction)

Step 2: Remove



Step 3: Disposal

~~-Burn?~~

~~-Landfill?~~

-Global Plastic recycling market?

-Research needed for safe end of life solutions

.

Where should all the flame retarded foam go?

Yucca Mountain?

Which Building Insulation Use Flame Retardants?

- Batt Insulation
  (Glass and Mineral Wool)

- Board Insulation
  (Polyurethane, Polyisocyanurate, Polystyrene)

- Blown-in Insulation
  (Cellulose, Fiberglass)

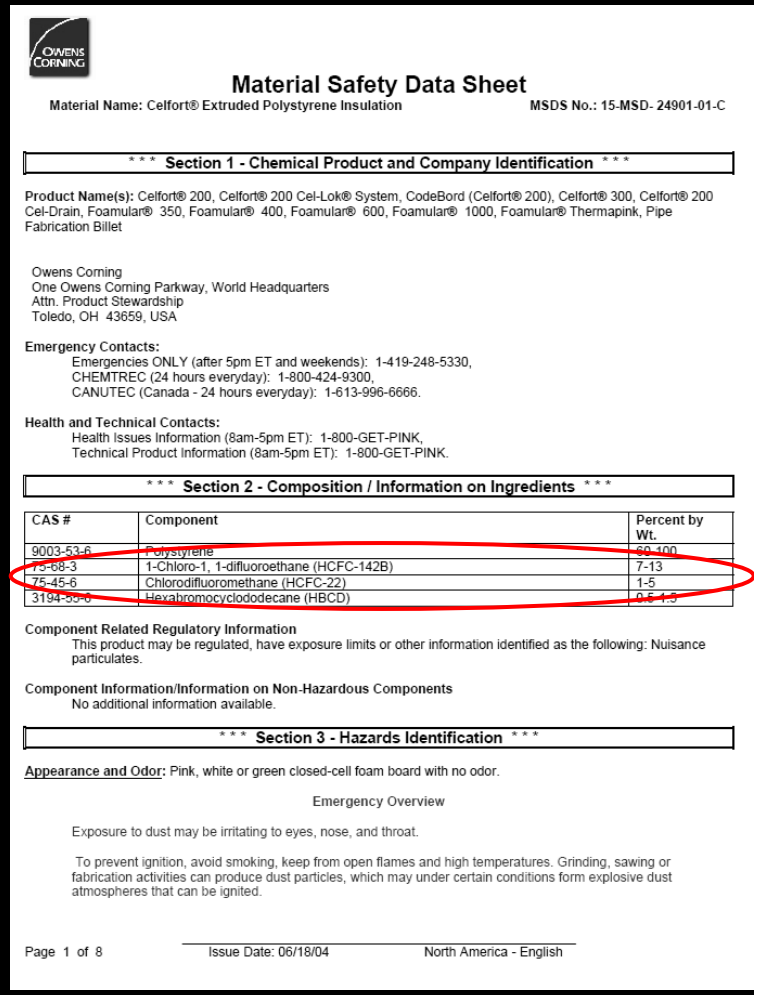
- Poured-in Insulation
  (Perlite, Vermiculite)

- 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



OWENS CORNING

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	69-100
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.

Page 1 of 8 Issue Date: 06/18/04 North America - English

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 product)

Mineral Wool (Rockwool)

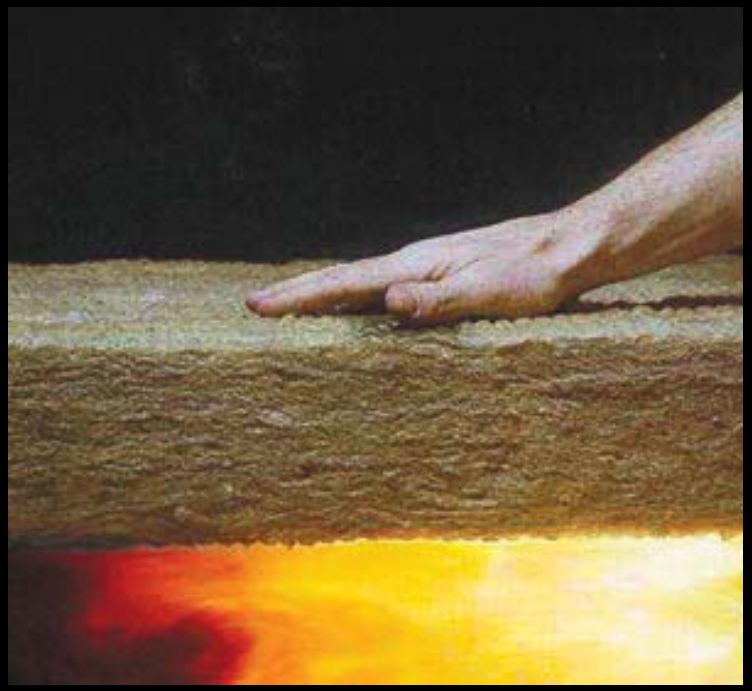
Primary Form	Cost / sq.ft. / R (materials & labor)	Thermal resistance (R- value per inch)	Raw Materials	Known Health Issues	Fire Retardant	Water Resistant	Embodied Energy
Board	$$	4.2	Slag wool fiber and/or basaltic rock, phenolic resin	Can irritate and congest lungs during installation	NA	Yes	Low (waste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

TYPICAL SIZES & USES

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

EXAMPLE MANUFACTURERS

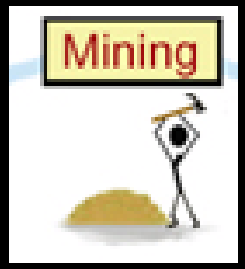
- Thermafiber Rainbarrier (thermafiber.com)
- Roxul Board Insulation (www.roxul.com)



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?

Electronics Life Cycle

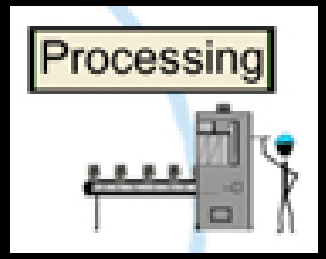


Stage 1 Mining

To manufacture a desktop PC and monitor, one needs

1.8 tons of materials
- 530 lbs of fossil fuels,
- 1.5 tons of water
- 48 lbs of chemicals

(2004 United Nations University study).



Stage 2: Processing of Raw Materials

- Ore is turned into the plastics, wires, glass and other parts of a computer.
- Chemicals can escape into air, soil and or groundwater.
- Workers who live near the facilities can have toxic exposures both in their homes and the workplace.

Stage 3: Electronics Manufacturing

- Parts are combined into electronics products.
- Toxic solvents can be used to clean chips
- Manufacturing processes have led to of cancer and reproductive problems in workers and surrounding communities.

Selenium
Exposure to high concentrations causes Selenosis, which can cause hair-loss, nail brittleness, and neurological abnormalities (i.g. numbness and other odd sensations in the extremities).[12]

Beryllium
Exposure can cause lung cancer and chronic beryllium disease (beryllicosis) (affects lungs).[3]

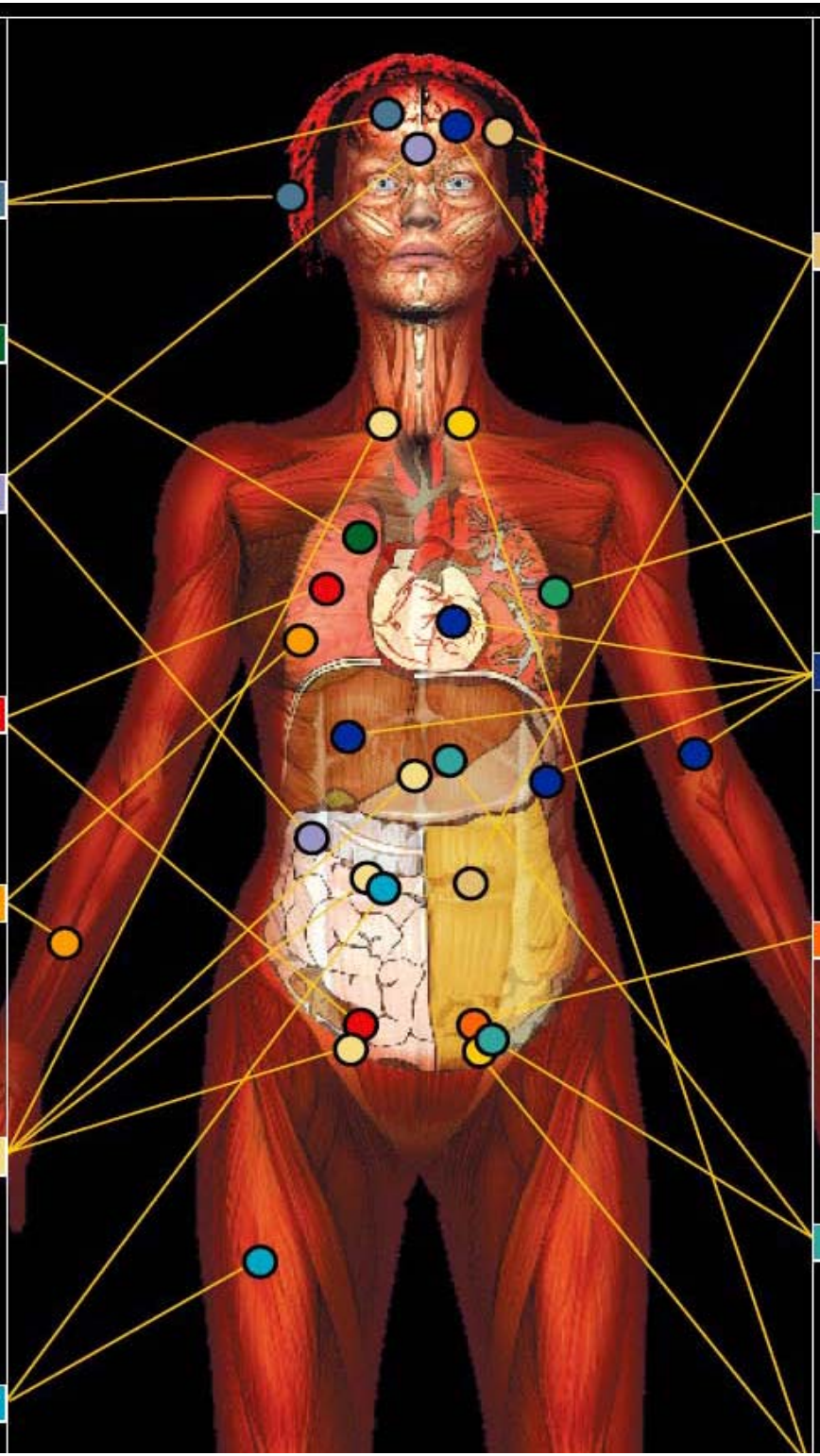
Mercury
Exposure through ingestion or inhalation can cause central nervous system damage and kidney damage.[1]

Chromium (IV) - Hexavalent Chromium
Exposure can cause strong allergic reaction (linked to Asthmatic Bronchitis) and DNA damage to cells. Workers are exposed at disposal stage and Chromium (IV) can also be released into the environment from landfills and incineration.[1]

Arsenic
Long-term exposure may cause lung cancer, nerve damage and various skin diseases. Arsine gas (AsH3), used in tech manufacturing, is the most toxic form of arsenic.[1]

Trichloroethylene (TCE)
Exposure to TCE (depending on amount and route) can cause liver and kidney damage, impaired immune system function, impaired fetal development, or death. Manufacturing workers and communities where TCE leaches into drinking water are at greatest risk.[13]

Cadmium
Long-term exposure can cause kidney damage and damage to bone structure is also a known carcinogen. Short term or acute exposure can cause weakness, fever, headache, chills, sweating, and muscle pain.[5]



Lead
Exposure can cause brain damage, nervous damage, blood disorders, kidney damage, and developmental damage to fetus. Children are especially vulnerable. Acute exposure can cause vomiting, diarrhea, convulsions, coma, or death.[8]

Polyvinyl chloride (PVC)
PVC is the most used plastic, found in everyday electronics. When burned it produces large quantities of hydrogen chloride gas, which combines with water to form hydrochloric acid (HCl). Inhaling HCl can cause respiratory problems. Production and incineration of PVC creates dioxins.[11]

Barium
Exposure may lead to brain swelling, muscle weakness, damage to heart, liver and spleen, or increased blood pressure.[1]

Brominated flame retardants (BFRs)
Suspected of hormonal interference (damage to growth and sexual development), and reproductive harm, BFRs are used to make materials more flame resistant. Exposure studies reveal BFRs in breast milk and blood of electronics workers, among others.[4]

Polychlorinated biphenyls (PCBs)
Toxic effects of PCBs include immune suppression, liver damage, cancer promotion, nervous damage, reproductive damage (both male and female), and behavioral changes. PCBs were widely used (prior to 1980) in transformers and capacitors. Though banned in many countries, they are still present in e-waste.[10]

Dioxins and Furans
Exposure can cause hormonal disruptions, damage to fetus, reproductive harm, and impairment of immune system. These highly toxic compounds bio-accumulate (concentrate in the body) and persist in the environment.

Stage 4: Consumer Use

- "Planned Obsolescence" can m**ake it** difficult and expensive to repair or upgrade,

- A short life span of creates greater pressure for raw materials, manufacturing, and contributes to the e-waste problem.

STAGE 5: “Recycled E-Waste” & Where it Goes

- Most recycled e-waste is exported to or developing countries or U.S. prisons
- Workers lacking proper protection smash open leaded glass tubes and melt plastics with toxic flame retardants to get at valuable metals.
- Plastics and toxic components are burned in open pits, dumped into rivers, and/or piled into mountains of e-waste

What happens to e-waste that is “recycled?”

The majority of e-waste collected for recycling is exported to Asia and Africa.

CEH

© Basel Action Network

Final Stage: Disposal of Electronics

- There are currently about 500 million obsolete computers in the U.S. A single computer monitor can contain up to 4-8 lbs of lead
- Electronic products contain mercury, cadmium and other harmful metals and halogenated chemicals.
- These chemicals can migrate out of landfills and into soil, air, water and eventually the food supply.

The Solution: Less Toxic Green Designs

Products should be designed to be

- less toxic,
- allow for repairs and upgrades
- easily recycled

Customer demand can drive such changes

Electronics Purchasing Guidelines

- Manufacturer takeback of equipment
- Reduction of toxic materials & components
- Increased recycled content
- Reduced and less toxic packaging
- Upgradeability
- Longevity
- Responsible End-of-Life Management including E- waste bans on export & prison labor
- Clean manufacturing practices
- Protection of workers rights/health & safety
- Design for reuse and recycling
- Energy efficiency

Report of TV Recycling Company Programs

Final grade: A	None	No TV companies earned As again this time.
Final grade: B-	Sony (61 pts) Samsung (61 pts)	Sony was the first TV company to launch a national takeback program. They are in the same position as in November. But Samsung rose from a C (45 pts) to a B-.
Final grade: C+	Best Buy (56 pts) Walmart (56 pts)	Best Buy went beyond just taking back their own brand, and launched a national takeback program to accept all brands of TVs at all stores. Walmart uses the Samsung program.
Final grade: C	LG (46 pts) Panasonic (40 pts) Sharp(41 pts) Toshiba(39 pts)	Panasonic, Sharp, and Toshiba moved up from D grades in November to C's this time.
Final grade: D	None	All the companies earning D's last November have moved up to C's for June 2009.
Final grade: F	Funai Hitachi JVC Mitsubishi Philips Sanyo Target Thomson Vizio Westinghouse	These companies have no voluntary takeback programs at all. All earned F's last November and none of them have made any progress.

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