Tackling Toxics:
For Healthier Products, People & Planet

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Chemistry, UC Berkeley
Green Science Policy Institute

July, 2019
Brominated Tris Flame Retardant
Tris (2,3-dibromopropyl) phosphate

- In children’s sleepwear 1975 to 1977
- Up to 10% of the weight of fabric
- In children’s urine
- Mutagen and possible carcinogen
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
TRIS-Treated Children's Garments Banned

April, 1977

Chlorinated Tris replaced Brominated Tris

- Removed from pajamas in 1978
- Used in furniture until 2012
Annapurna
A WOMAN'S PLACE

The dramatic story of the first American ascent of one of the world's highest peaks

ARLENE BLUM
20TH ANNIVERSARY EDITION
With a new Preface and Afterword by the author
GREEN SCIENCE POLICY INSTITUTE

Policy & Purchasing Change

Education

Research

Retreats

Policy & Purchasing Change
U.S. Toxic Substances Control Act (1976)

• 62,000 previous chemicals “grandfathered”

• 23,000 new chemicals
  – 85% have no health data
  – 67% have no data at all

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

GREEN SCIENCE POLICY INSTITUTE
GreenSciencePolicy.org
Regrettable Substitution

Decabromodiphenyl ether

Concerns:
• Persistence
• Bioaccumulation
• Toxicity

Decabromodiphenyl ethane

Concerns:
• Persistence
• Bioaccumulation
• Toxicity
EVALUATING TENS OF THOUSANDS OF INDIVIDUAL CHEMICALS IS UNWORKABLE
BUT ADDRESSING SIX GROUPS OF CHEMICALS OF CONCERN IS MANAGEABLE
Six Classes Videos
An innovative approach to reducing toxics

1. Highly Fluorinated
2. Antimicrobials
3. Flame Retardants
4. Bisphenols + Phthalates
5. Some Solvents
6. Certain Metals

VIEW and SHARE: www.SixClasses.org
Healthier products, healthier people in four minutes!
Is it necessary?

Is it worth it?

Is there a safer alternative?
Classes I to 3
PFAS
(Per- and polyfluoroalkyl substances)

Carbon-Fluorine bond strength:
- Leads to oil and water repellency
- “Forever chemicals” -- last for geologic time!
Published 2007

Stain-Resistant, Nonstick, Waterproof, and Lethal
The Hidden Dangers of C8
Callie Lyons
Ohio River Valley: West Virginia Manufacturing Plant

• PFOA used to manufacture Teflon
• Releases to water & air
• 70,000 + residents with contaminated drinking water
• C8 Health Study
PFAS exposure is a health concern

Exposure linked to health risks:
Cancer, elevated cholesterol, obesity, immune suppression, and endocrine disruption

(Ref: Lewis et al., 2015; Grandjean et al., 2012; Braun et al., 2016; Barry et al., 2013)

Courtesy, Cindy Hu, Harvard University
Common Uses

- Carpets
- Carpet Cleaning Products
- Food Packaging
- Furnishings
- Cosmetics
- Outdoor Gear
- Clothing
- Adhesives and Sealants
- Protective Coatings
- Non-Stick Cookware
- Car Seats
- Firefighting Foam

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Pathways to the Environment

From California DTSC: Product-Chemical Profile for PFAS in Carpets and Rugs
PFAS and Carpet

- PFAS-treated carpet linked to high PFAS blood levels
“Regrettable” Substitution?

Long chain phased out:
- Extreme persistence
- Bioaccumulation
- Toxicity

Short chain concerns:
- Extreme persistence
- Build-up in plants
- Suspected toxicity
- More mobile
- Clean up more difficult

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AGC – THE FIRST COMPANY TO FULLY CONVERT TO PFOA-FREE* WATER AND OIL REPELLENT

AsahiGuard® E Series is a fluorinated water and oil repellent providing sustainable alternatives for many applications, including paper packaging, textiles, apparel, non-wovens, natural and synthetic leathers and home furnishings based on proven AGC C6 chemistry. AsahiGuard E-Series offers high performance

• “C6 polymers are proven safe for their intended use”
• “Evaluated by regulators, showing they are safe and effective”
• “C6 polymers cannot break down to C8”

https://www.agcce.com/asahiguard-e-series/
May 2015  The Madrid Statement on Highly Fluorinated Chemicals

“We call on the international community to cooperate in limiting the production and use of PFASs and in developing safer non-fluorinated alternatives.”

Signed by 230 scientists from 40 countries

2015: Environmental Health Perspectives
Chemicals in Your Popcorn?

What do a pizza box, a polar bear and you have in common?

All carry a kind of industrial toxicant called poly- and perfluorooalkyl substances, or PFASs, that do two things: They make life convenient, and they also appear to increase the risk of cancer.

The Lawyer Who Became DuPont’s Worst Nightmare

Rob Bilott was a corporate defense attorney for eight years. Then he took on an environmental suit that would upend his entire career and expose a brazen, decades-long history of chemical pollution.
May 2016
EPA Lifetime Health Advisory Level of 70 ng/L PFOA + PFOS

Drinking Water Health Guidelines
(parts per trillion)

1987

DuPont
PFOA: 5000

1991

DuPont
PFOA: 1000

2009

U.S. EPA
PFOA: 400
PFOS: 200

U.S. EPA
PFOA & PFOS: 70

New Jersey
PFOA: 14

PFOS: 20

May 2016

New York
PFOA: 10
PFOS: 10

Nov. 2017

July 2019
New data suggests PFOA limit as low as 0.1 ppt

- Linda Birnbaum, Director National Toxicology Program

- 700 x lower than EPA health advisory

- Based on rodent study linking PFOA to pancreatic cancer

- “...I would not be surprised if the safe level of PFAS for humans is as low as 1.0-0.1 PPT.”

https://theintercept.com/2019/06/18/pfoa-pfas-teflon-epa-limit/
Michigan

• Wolverine treated leather with Scotchguard (PFOS)
  • Leather scrap dumped
  • Sludge applied to fields

• PFOA + PFOS level up to 58,000 ppt
  842 times EPA health advisory level!
New Mexico

• Cannon Air Force Base
  • Firefighting foam entered groundwater
  • PFAS migrated from base to dairy wells to cows to milk
  • Farmer: “I can’t sell the milk. I can’t sell beef. I can’t sell the cows. I can’t sell crops on my property.”

• PFOS level up to 12,000 ppt
  171 times EPA health advisory level!
Maine

• Biosolids spreading led to contamination of
  • Local municipal supply well
  • Milk at dairy

• Maine DEP:
  • All biosolids must now be tested for PFAS prior to use
  • Initial testing: nearly all biosolids exceed state screening levels for PFOS and/or PFOA (5.2 and 2.5 ng/g)

https://theintercept.com/2019/06/07/pfas-chemicals-maine-sludge/

See also: Venkatesan and Halden, J. Hazard Mater., 2013
What to do with PFAS-contaminated soil?

• “Cannot be disposed of at a landfill, cannot be re-located, so the soil pile just sits there waiting for someone to come up with a treatment technology...very expensive.”
Water Treatment Costs:
North Carolina

Brunswick County: reverse osmosis filtration for 25,000 customers:
- $99M to build
- $2.9M to operate

Cape Fear Public Utility Authority activated carbon filtration plant:
- $46M to build
- $2.7M to operate each year

Wilmington Star News, May 9th and 10th, 2018
PFAS are Problematic & Difficult to Clean Up

Prevention is Preferable!
Recommendation:

Only use PFAS when essential.

Find safer alternatives if possible.
Fluorine in U.S. fast food packaging paper

(Percent positive; 400 products sampled)

Adopted from Schaider L. 2016 *Fluorinated compounds in U.S. fast food packaging.*

Should these products be considered compostable?
Researchers found fluorinated chemicals in one-third of the fast food packaging they tested, according to a report cnn.it/2jWU6Rw

Researchers find "another reason" to avoid fast food: Chemicals in the packaging

Substances with links to health problems have been found in wrappers and containers, where they can leach into food.
washingtonpost.com

The Nasty Ingredient in Fast-Food Wrappers
mojo.ly/2jCPzA4

United States Senate
WASHINGTON, DC 20510

March 9, 2017

Mr. Daniel S. Schwartz
Chief Executive Officer
Restaurant Brands International Inc.
226 Wyecroft Road,
Oakville, Ontario L6K 3X7,
Canada

Dear Mr. Schwartz:

We write to inquire about Burger King’s use of potentially harmful fluorinated chemicals in food wrappers, bags, boxes, or other kinds of food packaging. Per and polyfluoroalkyl substances (PFASs) represent a class of chemicals sometimes used in fast food packaging to prevent grease and sauces from seeping through packaging. These chemical compounds have been
Microwave Popcorn Bags

• High PFAS concentrations ¹⁻⁴

• Coop Denmark - halted popcorn sales in 2015 due to PFAS

• RESULT: PFAS-free popcorn bags

PFAS and Carpet

- CDC: “The greatest source of exposure to PFOA and PFOS for toddlers and children is hand-to-mouth activities from treated carpets.”

San Francisco City Carpet Regulation

(courtesy Jen Jackson)

**NO**
- PFAS
- Flame Retardants
- Antimicrobials

(among other sustainability provisions)
BRANDS ARE ELIMINATING HIGHLY FLUORINATED CHEMICALS

IKEA  |  H&M  |  Crate&Barrel  |  LEVI STRAUSS & CO.

PUMA  |  benetton  |  ESPRIT  |  adidas

MARKS & SPENCER  |  MANGO  |  BURBERRY  |  ZARA
Moving away from PFAS

- Carpets
- Carpet cleaning products
- Food packaging
- Furnishings
- Cosmetics
- Outdoor gear
- Clothings
- Adhesives and sealants
- Protective coatings
- Non-stick cookware
- Car seats
- Firefighting foam
Firefighting foam (AFFF)

76% of sites likely related to firefighting foam use

- Military sites
- Airports
- Fire training
- Past fires

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Northeastern U. and EWG Site Tracker, 10/4/18
Waste Water Treatment Plants

- **Sources of PFAS loading**
  - Industrial – electroplating, firefighting foam...
  - Consumer – carpets, apparel, packaging, cosmetics...
  - Landfill leachate

- **Conventional treatment trains ineffective for PFAS**
  - Precursors break down during treatment so there can be more toxic PFAS in effluent than in influent!

- Long-chains partition to biosolids
- Short-chains partition to effluent
PFAA-precursors

- E.g., fluorotelomer phosphate esters (monoPAPs or diPAPs)
  - Used in paper products
2020 Defense Bill (NDAA)

House
• DoD foam phase out
• USGS monitoring
• $5M for health study
• Superfund listing
• Clean Water Act
• Many more...

Senate
• DoD foam phase out
• USGS monitoring
• $10M for health study
• Drinking water standard for PFOA + PFOS in 2 y
• Toxics Release Inventory
• Firefighter blood testing
PFAS Central: sharing notable news, scientific papers & events

NEWS
PFAS Chemicals to be Banned in Firefighting Foam Used on Military Bases
U.S. Senator Kristen Gillibrand today announced that a provision she cosponsored to prohibit the Department of Defense from procuring firefighting foam that contains per- and polyfluoroalkyl substances (PFAS) passed the Senate Armed Services Committee as part of the annual National Defense Authorization Act (NDAA).
LEARN MORE

SCIENCE
Larval amphibians rapidly bioaccumulate poly- and perfluoroalkyl substances.
Toxic frogs lead to bioaccumulation in predator species.
LEARN MORE

POLICY
The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS
A recent Nordic Council study, The Cost of Inaction: A socioeconomic analysis of environmental and health impacts linked to exposure to PFAS, estimates the very high cost of harm to human health and the environment from PFAS exposure in Europe.
LEARN MORE

Although useful, PFAS or highly fluorinated chemicals are associated with serious health harm and can remain in the environment forever.
LEARN MORE
Class 2: Antimicrobials

Triclosan

Triclocarban

Courtesy: Dr. Gary Ginsberg
5 – 10 Seconds
(ineffective)

Lifetime exposure in aquatic organisms (toxic)

Source: US EPA
Fate of Triclosan in Activated Sludge WWTP

![Pie chart showing the fate of Triclosan (TCS) in an Activated Sludge WWTP.]

- **Mass in effluent**: 2 ±1% (55 g/d)
- **Mass in sludge**: 48 ±19% (1540 g/d)
- **Mass transformed/lost**: 50 ±19% (1640 g/d)

**Triclosan (TCS)**

- OH
- Cl
- Cl
- Cl
- Cl

*Courtesy: Dr. Rolf Halden*

*Heidler & Halden, Chemosphere 2007, 66(2):362-369*
Triclosan & Triclocarban: Key Sludge Pollutants

72 pharmaceuticals & personal care products studied

Courtesy: Dr. Rolf Halden

EPA Method 1694
The Florence Statement on Triclosan and Triclocarban

Documents the scientific consensus about:
- potential for harm
- recommendations to prevent further harm

Signed by 205 international scientists

2017: Environmental Health Perspectives
Class 3 Flame retardants
Updating 1970s Flammability Standards

- Children’s sleepwear -- 1976

- Furniture and baby product foam -- 2014

- Foam building insulation

- Electronics cases
Technical Bulletin 117

– Required furniture foam to withstand a small open flame for 12 seconds

– No significant fire safety benefit (fires start in exterior fabric not filling)
PentaBDE
Flame Retardant

Used from 1975 to 2004 to meet TB117.

98% of use in foam in US and Canada in 2003
Flame retardants increase smoke toxicity more than they reduce fire growth

Flame retardants delay, but don’t prevent ignition
Then, flame retardants can increase....

- Soot and Smoke
- Carbon Monoxide and Hydrogen Cyanide
- Dioxins and Furans

Hull 2017; Bocchini 2009; Mennear 1994
Furniture foam flame retardant (PentaBDE) associations with human health problems

Increased time to pregnancy
Altered thyroid hormone
Thyroid disease in women

Impaired attention
Poorer coordination
Lower IQ
Developmental toxicity
Baby boys’ genital problems
Lower birth weight
Delayed puberty in girls
Earlier puberty in boys

Main et al. 2007; Goodyer et al. 2017;
From Products to People
NOAA Finds PentaBDE in Sediments & Bivalves
PBDEs in the Lower Columbia & Willamette Rivers, February 25, 2010

PBDEs in Salmon in the Columbia
TB117 Fire Safety Benefit?

TB117 foam ~ Non - TB117 foam

“No significant, consistent difference...”

Babrauskas et al. 2011; Talley 1995; Mehta (CPSC) 2012
Increased fire safety without flame retardants

Assembly Bill 706, Senate Bill 772, Senate Bill 1291, Senate Bill 147
Paid for by Californians for Fire Safety:

- Albemarle
- Chemtura
- Israel Chemicals LTD (ICL)
Playing with fire

A deceptive campaign by industry brought toxic flame retardants into our homes and into our bodies. And the chemicals don't even work as promised.

Dr. David Heimbach knows how to tell a story. Before California lawmakers last year, the noted burn surgeon grew gapes from the concern as he described a 9-week-old baby girl who was burned in a fire started by a candle while she lay on a pillow that lacked flame retardant chemicals.

"This is a tiny little person, no bigger than my Italian greyhound at home," said Heimbach, gesturing to approximate the baby's size. "Half of her body was severely burned. She ultimately died after about three weeks of pain and misery in the hospital."

Heimbach's passionate testimony about the baby's death made the long-term health concerns about flame retardants voiced by doctors, environmentalists and even firefighters sound abstract and petty.

But there was a problem with his testimony: It wasn't true. Records show there was no dangerous pillar or candle fire. The baby he described didn't exist.

Neither did the 9-week-old patient who Heimbach told California legislators died in a candle fire in 2009. Nor did the 4-week-old patient who he told Alaska lawmakers was fatally burned in her crib in 2010.

Heimbach is not a prominent burn doctor. He is a star witness for the manufacturers of flame retardants.

His testimony, the Tribune found, is part of a decades-long campaign of deception that has loaded the furniture and electronics in American homes with pounds of toxic chemicals linked to cancer, neurological deficits, developmental problems and impaired fertility.

The tactics started with Big Tobacco, which wanted to shift focus away from cigarettes as the cause of fire deaths, and continued as chemical companies worked to preserve a lucrative market for their products, according to a Tribune review of thousands of government, scientific and internal industry emails the public's fear of fire and helped organize and steer an association of top fire officials that spent more than a decade campaigning for their cause.

But today, scientists know that some flame retardants escape from household products and settle in dust. That's why tod-

...
California TB117-2013
City of San Francisco
Upholstered Furniture & Children’s Products

NO Flame Retardants

(courtesy Jen Jackson)
California Bans Flame Retardants
in furniture, children’s products & mattress foam
Signed September 30, 2018

“Toxic flame retardant chemicals have put consumers, children, and firefighters at risk for decades. Today we say no more.”

-AB 2998, Sponsor: Assemblyman Bloom
Flame Retardants in Electronics
Increased FRs from Electronics in Use

Study of flame retardants in air of a newly built classroom at 8 timepoints

Recycling Flame Retarded Plastics
Flame Retardants in Kitchen Utensils

- Black plastic often contains BFRs
- BFRs found in 34% of tested utensils
- Up to 20% of BFRs transferred to hot cooking oil

Kuang et al., Science of the Total Environment, 2018
PETITION: U.S. Consumer Product Safety Commission

Declare as “banned hazardous substances”:
• Children’s products
• Residential furniture
• Mattresses & mattress pads
• Plastic electronics enclosures

with the class of non-polymeric organohalogen FRs added

GRANTED – 2017

National Academy of Science Scoping Report, 2019:
“The only possible practical approach for a set of chemicals as large as the OFRs is a class approach.”
EU Ban on Flame Retardants in Electronics Cases

- Ecodesign directive bans all organohalogen flame retardants
  - For cases and stands of electronic displays and TVs
  - Unanimously approved by 24 member states on December 19, 2018
  - Starting in 2021
  - Justification is need for plastic recycling in the Circular Economy
Flame Retardants
in Building Insulation
Do we Need Flame retardants in Building Insulation?

- Behind a thermal barrier?
- Beneath a concrete foundation?

Building codes can be safety updated to allow the use of flame retardant free polystyrene insulation below slab.

—California State Fire Marshal study
Jan. 2019: California code revision allows flame retardant-free insulation below a slab

Nov. 2019: ICC Members - Please vote to approve RB131

Fall 2020: Oregon Building Codes Division updates Residential Specialty Code

To support healthier Oregon building codes, speak with Arlene or email joe@GreenSciencePolicy.org
Class Four: Bisphenols

FUNCTIONS: hardening agents, strengtheners, stabilizers

Class Four: Phthalates

FUNCTIONS: plasticizers, lubricants, solvents, fragrances
Class 5: Some Solvents

FUNCTIONS: dissolving and dispersing other substances
Class 6: Certain Metals

Mercury  Arsenic  Cadmium  Lead

FUNCTIONS: conductors, malleable, resistant to corrosion
Six Classes Videos
An innovative approach to reducing toxics

1. Highly Fluorinated
2. Antimicrobials
3. Flame Retardants
4. Bisphenols + Phthalates
5. Some Solvents
6. Certain Metals

VIEW and SHARE: www.SixClasses.org
Healthier products, healthier people in four minutes!
For monthly e-newsletters, give Arlene your card or sign our mailing list.

This talk will be under Past Events at www.GreenSciencePolicy.org.
Workshop

Tackling Toxics:
The Class Concept for Healthier Water

4:00 pm
July 25, 2019
By limiting use of the Six Classes

We can have a healthier world.

For more information:
GreenSciencePolicy.org
Workshop
Tackling Toxics:
The Class Concept for Healthier Water

4:00 pm
July 25, 2019
Introductions

• Name

• Your position and where you work

• What brought you here?
Groups

• 1. Pre-treatment
• 2. Education & Outreach
• 3. Biosolids
• 4. Stormwater
• 5. Other public health and government
Group Instructions

- Group of four or five with time keeper
- Pick one class and one product. How can you use the class concept for healthier water?
- Think about ideas and write 5 minutes
- Report back ACTIVE LISTENING 3 minutes
- Choose 2 ideas for discussion 5-10 minutes
- Flipchart
- Group report back and discussion
Commitments

Name
Partners
To help create the future I envision, during the next month I will:
1.
2.
3.