Brominated and Chlorinated Organic Chemical Compounds Used as Flame Retardants (BFRs and CFRs)

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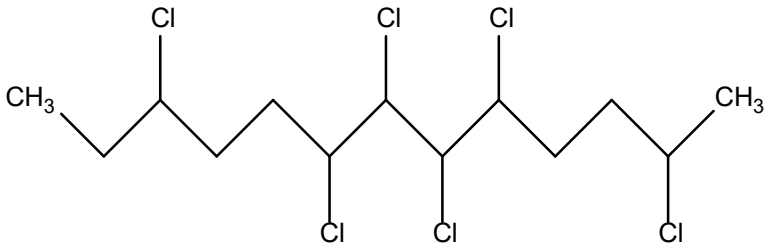
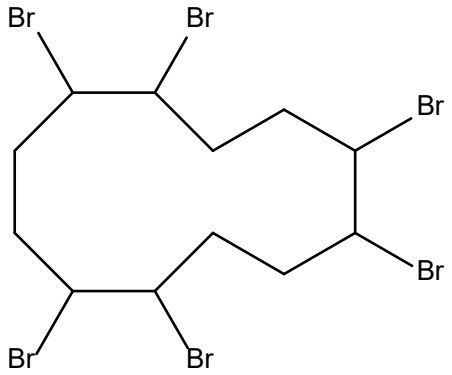
Structures of BFRs and CFRs

- Aliphatic

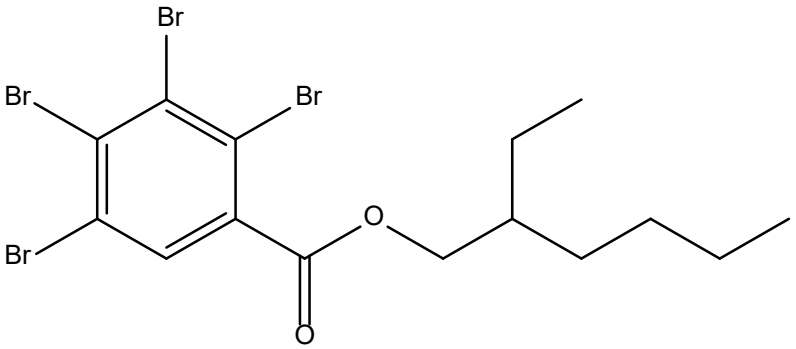


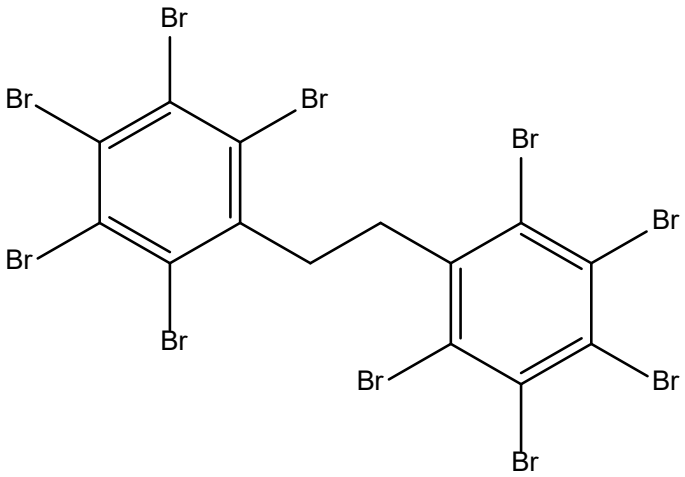
- Cycloaliphatic



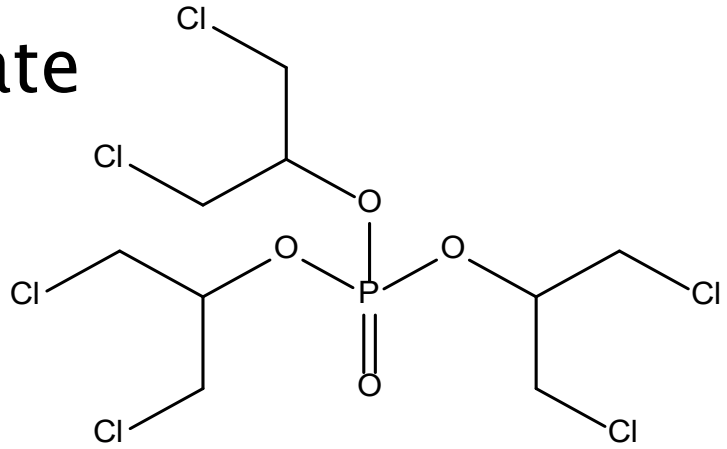
Structures of BFRs and CFRs (cont.)

- Aromatic





- Organophosphate



Additive flame retardants

- Incorporated, but not chemically bound
- Over time, released into the environment

Reactive flame retardants

- Chemically bound to material in the product
- Unreacted flame retardant in the product can be released

Uses and production/import volume

- Uses: plastic housings for electrical and electronic equipment, printed circuit boards, foam insulation in construction materials, upholstered furniture, textiles, paints

- Current production/import volume is not available

- In 2002, U.S. production/import volume (millions pounds/yr) was:

  TBBPA: > 100-500
  HBCD: > 10-50
  TDCPP: > 10-50
  decaBDE: > 50-100
  pentaBDE: >10-50

Occurrence in the environment

- Persistent
  - Air, sediment and soil, sewage sludge, streams, Great Lakes, SF Bay.
  - Fish, marine mammals, predatory bird eggs
- Found in house dust, office dust, indoor air

Evidence of human exposure

Certain BFRs and CFRs have been found in:

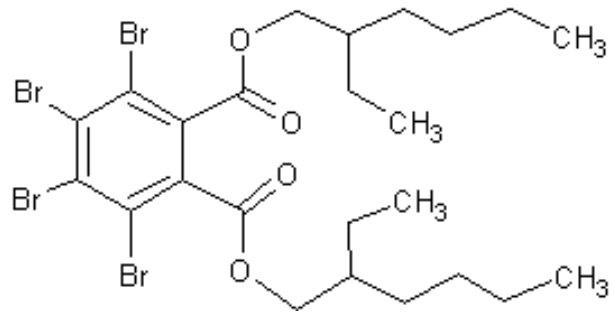
- Blood (e.g., HBCD, TBBPA)
- Breast milk (e.g., Chlorinated paraffins, HBCD, TBBPA)
- Adipose tissue (e.g., HBCD, TBBPA, TDCPP)
- Umbilical cord and/or umbilical cord blood (e.g., HBCD, 2,4,6-tribromophenol)

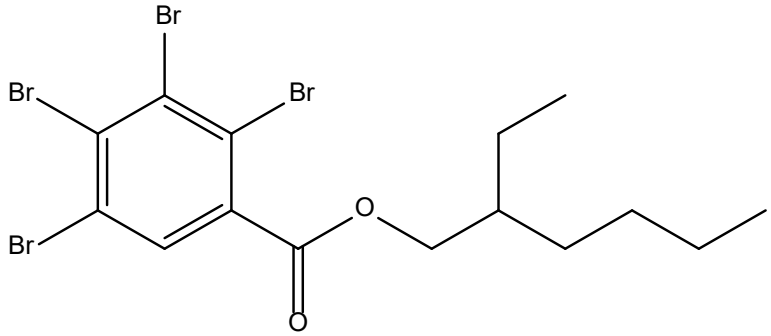
Specific California exposure concerns

- Technical Bulletin No. 117 (TB 117) requires all upholstered furniture to meet specified flammability standards
- TB 117 has resulted in extensive use of chemical flame retardants in California
- Prior to 2006, the pentaBDE commercial mixture was the primary flame retardant in furniture foam
- Effective 2006, California banned penta- and octa-BDE mixtures, substitute flame retardants are emerging as a result

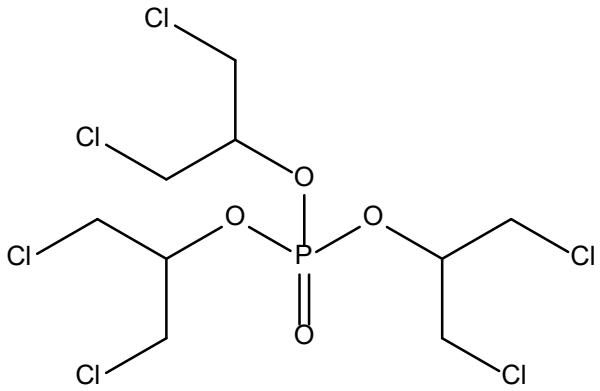
PBDE substitutes in furniture foam

- Firemaster 550





- TDCPP



Known or suspected health effects of BFRs and CFRs

- Cancer
- Developmental toxicity
- Endocrine disruption
  - Thyroid, estrogen, androgen disruption
- Neurotoxicity
  - Inhibition of neurotransmitter uptake
- Immunotoxicity

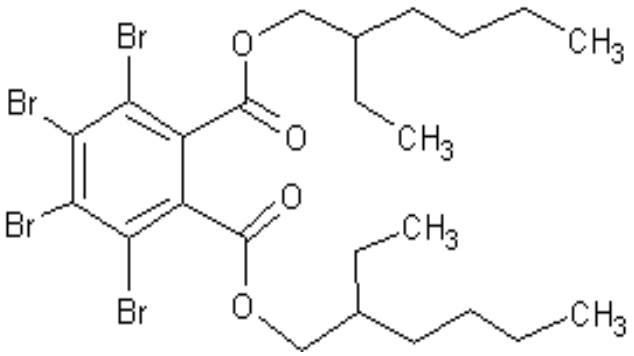
Known or suspected health effects

	Cancer	Develop-mental Toxicity	Endocrine Disruption
2,2-Bis(bromomethyl)-1,3-propanediol	✓		
Chlorendic acid	✓		
Dechlorane	✓		
2,3-Dibromo-1-propanol	✓		
Hexabromocyclododecane	NT	✓	✓
pentaBDE mixture	IP	✓	✓
octaBDE mixture	NT	✓	✓
decaBDE	(✓)[1]	✓	✓
Polybrominated biphenyls	✓	✓	✓
Short-chain chlorinated paraffins	✓		
Tetrabromobisphenol A	IP		✓
Tetrabromobisphenol A bis(2,3-dibromopropyl ether)	NT		✓
Tetrabromoethylcyclohexane	NT		✓
2,4,6-Tribromophenol	NT	✓	✓
Tris(2,3-dibromopropyl)phosphate	✓		
Tris(1,3-dichloropropyl)phosphate	✓		
Tris(2-chloroethyl)phosphate	✓		
Vinyl bromide[2]	✓		

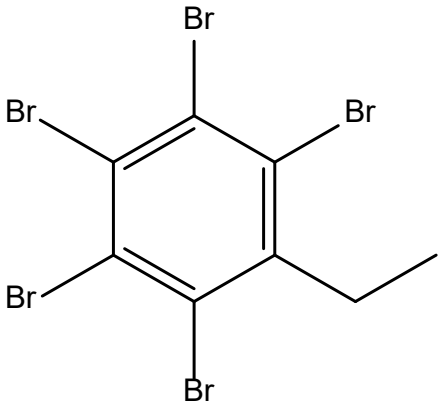
[1] *some evidence* of carcinogenicity
[2] copolymer in inherently flame resistant material
IP = NTP study planned or in progress
NT = not tested

Suspected health effects based on structural similarity

DEHP/brominated DEHP

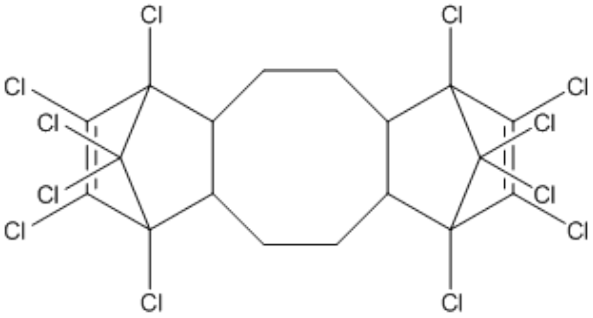


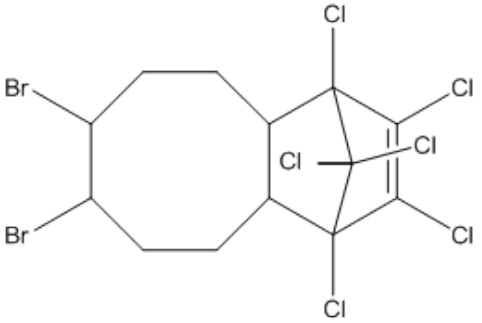
Ethylbenzene/brominated ethylbenzene



Suspected health effects based on common structural feature

Chlorinated norbornene moiety





Other carcinogens/developmental toxicants with chlorinated norbornene moiety:

- Chlorendic acid
- Dieldrin
- Chlordane
- Heptachlor
- Endrin

Need to assess efficacy of public health actions

- Significant concerns about persistence, bioaccumulation and known or suspected human health effects of BFRs and CFRs

- Biomonitoring BFRs and CFRs would
  - Assess the impact of the PBDE ban and determine whether PBDE substitutes are also accumulating
  - Determine whether other BFRs and CFRs are accumulating
  - Uncover environmental and human health concerns

Laboratory considerations

- Availability of analytical methods:
  - Methods for many BFRs or CFRs are either available or are being developed
- Adequate biospecimens:
  - BFRs and CFRs can be detected in blood or urine
  - In some cases, large sample volumes would be required
- Incremental analytical cost:
  - Analyses can be bundled with other BFRs/CFRs

Summary

- BFRs and CFRs are extensively used in California
- BFRs and CFRs have been found in people and the environment
- BFRs and CFRs have known or suspected health effects
- Laboratory methods are available and being developed for most compounds