



### At a Glance

- ❖ Class of brominated hydrocarbons that serve as flame retardants for electrical equipment, electronic devices, furniture, textiles and other household products.
- ❖ Structurally similar and exhibit low to moderate volatility.
- ❖ Exposure in rats and mice caused neuro-developmental toxicity and other symptoms.
- ❖ The U.S. Department of Health and Human Services states that PBBs are reasonably anticipated to be human carcinogens.
- ❖ EPA has calculated screening levels for PBBs in air, soil and tap water.
- ❖ Detection methods include gas chromatography, mass spectrometry and liquid chromatography.

### Introduction

This fact sheet, developed by the U.S. Environmental Protection Agency (EPA) Federal Facilities Restoration and Reuse Office (FFRRO), provides a summary of the contaminant group polybrominated biphenyls (PBBs), including physical and chemical properties; environmental and health impacts; existing federal and state guidelines; detection and treatment methods; and additional sources of information. This fact sheet provides basic information on PBBs to site managers and other field personnel who may encounter these contaminants at cleanup sites.

The manufacture of PBBs was banned in the United States in 1976 after an agricultural contamination incident in 1973 when PBB was accidentally mixed into animal feed, exposing millions of Michigan residents to contaminated dairy products, eggs and meat (ATSDR 2004; NTP 2014).

### What are PBBs?

- ❖ PBBs are a class of brominated hydrocarbons. They contain a central biphenyl structure surrounded by up to 10 bromine atoms (ATSDR 2004).
- ❖ PBBs were formerly used as additive flame retardants in synthetic fibers and molded plastics. They are no longer used in the United States (ATSDR 2004; NTP 2014).
- ❖ Three types of commercial PBB mixtures were: hexabromobiphenyl (hexaBB), octabromobiphenyl (octaBB) and decabromobiphenyl (decaBB) (ATSDR 2004).
- ❖ There are no known natural sources of PBBs (ATSDR 2004).
- ❖ PBBs are structurally similar to polychlorinated biphenyls (PCBs).
- ❖ PBBs are fat-soluble and hydrophobic (NTP 2014).

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**Exhibit 1: Physical and Chemical Properties of PBBs (ATSDR 2004)**

Property	PBBs		
	HexaBB	OctaBB	DecaBB
Chemical Abstracts Service (CAS) number	36355-01-8	27858-07-7	13654-09-6
Physical description (physical state at room temperature)	White solid	White solid	White solid
Molecular weight (g/mol)	627.4	785.2	943.1
Water solubility at 25°C (µg/L)	11	20 to 30	Insoluble
Boiling point (°C)	Not available	Not available	Not available
Melting point (°C)	72	200 to 250	380 to 386
Vapor pressure (mm Hg)	$5.2 \times 10^{-8}$ (at 25°C)	$7 \times 10^{-11}$ (at 28°C)	Not available
Octanol-water partition coefficient (log $K_{ow}$ )	6.39	5.53	8.58
Soil organic carbon-water coefficient (log $K_{oc}$ )	3.33 to 3.87 <sup>a</sup>	Not available	Not available
Henry's law constant at 25°C (atm-m <sup>3</sup> /mol)	$3.9 \times 10^{-6}$	Not available	Not available

Abbreviations: g/mol – gram per mole; µg/L – micrograms per liter; °C – degrees Celsius; mm Hg – millimeters of mercury; atm-m<sup>3</sup>/mol – atmosphere-cubic meters per mole.

<sup>a</sup> – Estimated value

## Existence of PBBs in the environment

- ❖ PBBs have been detected in air, sediments, surface water, fish and other marine animals (ATSDR 2004).
- ❖ PBBs do not dissolve easily in water and bind strongly to soil or sediment particles. This reduces their mobility in soil, sediment, surface and groundwater, but increases their mobility in the atmosphere, where they are attached to airborne particulate matter (ATSDR 2004).
- ❖ Volatilization from soil surfaces is expected to be low to moderate, depending on the number of bromine atoms. More brominated congeners (higher numbers of bromine atoms) tend to exhibit lower volatilities (NTP 2014).
- ❖ Even though PBBs are stable, they are susceptible to photolytic debromination when they are exposed to ultraviolet light (ATSDR 2004).
- ❖ As of 2016, PBBs had been identified at few sites on the EPA National Priorities List (NPL); however, the number of sites evaluated for PBBs is not well documented (EPA 2016a).

## What are the routes of exposure and the potential health effects of PBBs?

- ❖ Routes of potential human exposure to PBBs are ingestion, inhalation or dermal contact (NTP 2014).
- ❖ Since PBBs are not produced or used in the United States, the general population can only be exposed from historical releases or products (ATSDR 2004).
- ❖ The U.S. Department of Health and Human Services (DHHS) states that PBBs are reasonably anticipated to be human carcinogens based on sufficient evidence of carcinogenicity from experimental animal studies (NTP 2014).
- ❖ The International Agency for Research on Cancer (IARC) classified PBBs as “probably carcinogenic to humans” (IARC 2016).
- ❖ Studies on mice and rats, and evidence from cows exposed via feed show that PBBs cause neurotoxicity, weight loss, skin disorders, liver toxicity, kidney toxicity, thyroid toxicity immunotoxicity and cancer (ATSDR 2004; Birnbaum and Staskal 2004).
- ❖ Studies on animals and humans show that some PBBs can act as endocrine system disruptors, have been found in human breast milk, and tend to deposit in human adipose tissue (ATSDR 2004; Birnbaum and Staskal 2004; NTP 2014).

## Are there any existing federal and state guidelines and health standards for PBBs?

- ❖ EPA has not derived chronic oral reference doses (RfDs) for PBBs.
- ❖ EPA has calculated the following screening levels for residential soil, industrial soil and tap water (EPA 2017b):

Chemical	Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Tap Water (µg/L)
PBBs	0.018	0.077	0.0026

- ❖ For PBBs, EPA has also calculated a residential air screening level of  $3.3 \times 10^{-4}$  micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) and an industrial air screening level of  $1.4 \times 10^{-3} \mu\text{g}/\text{m}^3$  (EPA 2017b).
- ❖ The Agency for Toxic Substances and Disease Registry (ATSDR) has established a minimal risk level (MRL) of 0.01 mg/kg/day for acute-duration (14 days or less) oral exposure to PBBs (ATSDR 2016).

- ❖ Various states have adopted screening values or cleanup goals for PBBs in drinking water or groundwater, ranging from 0.0001 to 5 µg/L:

State	Guideline (µg/L)	Source
Indiana	0.026	IDEM 2016
Michigan	0.03	MDEQ 2015
Mississippi	0.00752	MS DEQ 2002
Nebraska	0.0022	NE DEQ 2012
New York	5	NYDEC 2016
Texas	0.0001	TCEQ 2016
West Virginia	0.0022	WV DEP 2009

- ❖ Some states have established soil standards or guidelines for PBBs, including Michigan, Mississippi, Nebraska, North Carolina, Texas, West Virginia and Wisconsin. The California Environmental Protection Agency (Cal/EPA) has established a No Significant Risk Level of 0.02 µg per day for PBBs (Cal/EPA 2017).

## What detection and site characterization methods are available for PBBs?

- ❖ Analytical methods for PBB detection include gas chromatography-electron capture detector (GC-ECD) for commercial samples, soil, plant tissue, water, sediment, fish, dairy and animal feed; high resolution GC (HRGC)/high resolution mass spectrometry (HRMS) for fish samples; GC-flame ionization detector (FID)/ECD for soil; and liquid

chromatography (LC)-GC-MS/FID for sediment (ATSDR 2004).

## What technologies are being used to treat PBBs?

- ❖ Research is being conducted at the laboratory scale on potential treatment methods for media contaminated with PBBs.

## Where can I find more information about PBBs?

- ❖ Agency for Toxic Substances and Disease Registry (ATSDR). 2004. "Toxicological Profile for Polybrominated Biphenyls." [www.atsdr.cdc.gov/toxprofiles/tp68.pdf](http://www.atsdr.cdc.gov/toxprofiles/tp68.pdf).
- ❖ ATSDR. 2016. "Minimal Risk Levels (MRLs)." [www.atsdr.cdc.gov/mrls/index.html](http://www.atsdr.cdc.gov/mrls/index.html)
- ❖ Birnbaum, L.S., and D.F. Staskal. 2004. "Brominated Flame Retardants: Cause for Concern?" Environmental Health Perspectives. Volume 112 (1). Pages 9 to 13.
- ❖ California Environmental Protection Agency (Cal/EPA) Office of Environmental Health and Hazard Assessment. 2017. "Proposition 65 No Significant Risk Levels for Carcinogens and Maximum Allowable Dose Levels for Chemicals

Causing Reproductive Toxicity."

[oehha.ca.gov/media/downloads/proposition-65/general-info/regsart7.pdf](http://oehha.ca.gov/media/downloads/proposition-65/general-info/regsart7.pdf)

- ❖ Indiana Department of Environmental Management (IDEM). 2016. "IDEM Screening and Closure Levels." [www.in.gov/idem/landquality/files/risc\\_screening\\_table\\_2016.pdf](http://www.in.gov/idem/landquality/files/risc_screening_table_2016.pdf)
- ❖ International Agency for Research on Cancer (IARC). 2016. "Agents Classified by the IARC Monographs, Volumes 1-107." [monographs.iarc.fr/ENG/Classification/index.php](http://monographs.iarc.fr/ENG/Classification/index.php)
- ❖ Michigan Department of Environmental Quality (MDEQ). 2015. "Rule 57 Water Quality Values." [www.michigan.gov/documents/deq/wrd-swas-rule57\\_372470\\_7.pdf](http://www.michigan.gov/documents/deq/wrd-swas-rule57_372470_7.pdf)

## Where can I find more information about PBBs? (continued)

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- ❖ Mississippi Department of Environmental Quality (MS DEQ). 2002. “Risk Evaluation Procedures for Voluntary Cleanup and Redevelopment of Brownfield Sites.” [www.deq.state.ms.us/MDEQ.nsf/pdf/GARD\\_brownfieldrisk/\\$File/Proced.pdf?OpenElement](http://www.deq.state.ms.us/MDEQ.nsf/pdf/GARD_brownfieldrisk/$File/Proced.pdf?OpenElement)
- ❖ National Toxicology Program. 2014. “Report on Carcinogens, Fourteenth Edition.” Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. <https://ntp.niehs.nih.gov/pubhealth/roc/index-1.html>
- ❖ Nebraska Department of Environmental Quality. 2012. Voluntary Cleanup Remediation Goals. [deq.ne.gov/Publica.nsf/xsp.ibmmodres/domino/OpenAttachment/Publica.nsf/D243C2B56E34EA8486256F2700698997/Body/ATTIY3JX.pdf](http://deq.ne.gov/Publica.nsf/xsp.ibmmodres/domino/OpenAttachment/Publica.nsf/D243C2B56E34EA8486256F2700698997/Body/ATTIY3JX.pdf)
- ❖ New York Department of Environmental Conservation (NYDEC). 2016. Water Quality Standards. [www.dec.ny.gov/chemical/23853.html](http://www.dec.ny.gov/chemical/23853.html)
- ❖ Texas Commission on Environmental Quality. 2016. “Texas Risk Reduction Program (TRRP) Protective Concentration Levels (PCLs).” [www.tceq.texas.gov/remediation/trrp/trrppcls.html](http://www.tceq.texas.gov/remediation/trrp/trrppcls.html)
- ❖ EPA. 2016a. Superfund Information Systems. Superfund Site Information. [cumulis.epa.gov/supercpad/cursites/srchsites.cfm](http://cumulis.epa.gov/supercpad/cursites/srchsites.cfm)
- ❖ EPA. 2017b. Regional Screening Level (RSL) Summary Table. <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables-june-2017>
- ❖ West Virginia Department of Environmental Protection (WV DEP). 2009. “Voluntary Remediation and Redevelopment Rule.” [www.dep.wv.gov/dlr/oer/voluntarymain/Documents/60CSR3%20VRRRA%20rule%206-5-09.pdf](http://www.dep.wv.gov/dlr/oer/voluntarymain/Documents/60CSR3%20VRRRA%20rule%206-5-09.pdf)

## Contact Information

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