ToxFAQs™: CABS/Chemical Agent Briefing Sheet

Polychlorinated Biphenyls (PCBs)

December 2005

What are polychlorinated biphenyls?

Characteristic	Description
Source	• Polychlorinated biphenyls (PCBs) are a group of 209 synthetic organic compounds that were manufactured in the U.S. between 1930 and 1977. PCBs were banned from industrial use in 1977. • There are no known natural sources of PCBs in the environment. • Chemically, PCBs are biphenyls with 1–10 substituted chlorine atoms.
Color/Taste	• PCBs are light (colorless or straw-colored) to dark-brown oils/liquids. They may also be slick resinous semi-solids. • PCBs have no known smell or taste.
Volatility	• The volatility of PCBs increases markedly with small increases in temperature
Congeners	• The different types of PCB chemicals are known as congeners, compounds distinguished by the number and location of chlorine atoms on the biphenyl structure.
Environmental impact	• Some PCBs are resistant to biodegradation and are chemically stable; thus, potential environmental risks may be present for a long time.

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What are other names for polychlorinated biphenyls?

Synonyms	• Chlorinated biphenyls • Chlorinated diphenyls • PCBs
Trade names	Trade name / Country: Aroclor — United States Clophen — Germany Fenclor — Italy Kanechlor — Japan Phenoclor — France

What are common uses for PCBs?

Uses*	Benefits
Coolants and lubricants in: • transformers • capacitors Also used in: • hydraulic fluids and lubricants • gas-transmission turbines	• Do not burn easily • Good insulating material

*commercial production of PCBs in the United States stopped in 1977

What happens when PCBs enter the environment?

PCBs do not readily break down in the environment and therefore may persist for a very long time. They can easily cycle between air, water, and soil.

Movement of PCBs in the environment	
Air	• Enter the air by evaporation from both soil and water. • Can be carried long distances. Have been found in snow and seawater in areas far away from where they were released into the environment, such as the polar latitudes. • In general, the lighter the type of PCBs (low chlorinated PCBs), the further they may be transported from the source of contamination. • Once in the atmosphere, PCBs are present as absorbed or adsorbed particles or as vapor in the air. They eventually return to land and water by settling as dust or precipitation (rain and snow). • As a gas, PCBs accumulate in the leaves and above-ground parts of plants, including food crops.
Water	• PCBs may: o be transported by currents o attach to bottom sediment or particles in the water o evaporate into the air • Highly chlorinated PCBs are more likely to settle into sediments while low-chlorinated PCBs tend to evaporate into the air. • Sediments containing PCBs can also release them into the surrounding water. • Through bioconcentration, PCBs accumulate in small organisms and fish to levels that may be many thousands of times higher than in the water. • Through biomagnification, PCBs progressively accumulate through successive levels of the food chain.

Soil	• PCBs stick strongly to soil particles and are not usually carried deep into the soil with rainwater. • PCBs do not readily break down and may remain in the soil for months or years • Evaporation appears to be an important way by which the lighter PCBs leave the soil

What are the sources, routes, and types of exposure to PCBs?

Sources of Exposure	Route of Exposure	Type of Exposure
• EPA reported in 2003 (the latest year for which information is available) that over 22 million pounds of PCBs were disposed of or released in the United States.	Ingestion	• Eating contaminated food. PCBs especially accumulate in fish and marine mammals such as seals and whales. • Drinking contaminated well water
	Inhalation	• Leaks from or fires in transformers, capacitors, or other PCB-containing products. • Breathing indoor air in buildings that have electrical devices containing PCBs (leakage of small amounts is common in older equipment containing PCBs) • Accidental spills and leaks during the transport of chemicals • Illegal or improper dumping of PCB wastes, i.e. old transformer fluids, leaks or releases from electrical transformers containing PCBs • Disposal of PCB-containing consumer products into landfills not designed to handle hazardous waste • Burning of PCB-containing wastes in municipal and industrial incinerators

What are the effects of exposure to PCBs?

Acute exposure: PCBs have low acute toxicity, but because they accumulate in the environment and in animal and human tissues, the potential for chronic or delayed toxicity is not insignificant.	
Dermal effects	• In humans, possible dermal effects may include: chloracne (skin eruption resembling acne that results from exposure to chlorine or its compounds) • simple erythematous eruptions with pruritus (small red eruptions with localized or generalized itching due to irritation of sensory nerve endings) • acute allergic eczematous contact dermatitis • burning sensation and edema (an abnormal excess accumulation of serous fluid in connective tissue or in a serous cavity) of the face and hands • thickening of the skin • excessive pigmentation of the skin and nails • excessive eye discharge • swelling of eyelids • distinctive hair follicles

Liver effects	In persons with systemic intoxication, usual signs and symptoms are: • jaundice (yellowish pigmentation of the skin, mucous membranes, and/or sclera of the eyes due to deposition of bilirubin (a breakdown product of hemoglobin) that follows impairment of bile production and discharge of bile (as in certain liver diseases) or excessive breakdown of red blood cells. • edema (an abnormal excess accumulation of serous fluid in connective tissue or in a serous cavity) • abdominal pain
Neurological effects	• headache • dizziness • depression • nervousness
Gastrointestinal effects	The following symptoms have been reported following acute and chronic exposures: • severe abdominal pain • nausea • vomiting • diarrhea
Toxic derivatives	Polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans can be formed during the manufacture of PCBs. Signs and health effects of exposure to these derivatives may include: • lymphoid depletion • thymic atrophy (shrinkage of the thymus gland) • liver damage, hemorrhage • chloracne (skin eruption resembling acne resulting from exposure to chlorine or its compounds)

Chronic exposure: Chronic PCB exposure can come from occupational settings and dietary intakes.	
Effects observed during pregnancy and postnatal development	PCBs • can cross the placental barrier and have been found in human umbilical cord blood and breast milk • may produce neurodevelopmental effects (reduced IQ) • may cause decreased birth weight
Reproductive hazards	• Findings regarding the effects of PCBs on female and male reproductive systems are inconclusive.
Carcinogenicity classification	<table><tr><th>Organization</th><th>Classification</th></tr><tr><td>**International Agency for Research on Cancer (IARC)**</td><td>Probably carcinogenic to humans (limited evidence of carcinogenicity in humans but</td></tr></table>

		evidence of carcinogenicity in experimental animals)
	National Toxicology Program (NTP)	Reasonably anticipated to be a human carcinogen: (there is limited evidence of carcinogenicity from studies in humans indicating that a causal interpretation is possible but that alternative explanations, such as chance, bias, or confounding factors, cannot be excluded).

What are the safety guidelines for exposure to PCBs?

<table>
<tr><th>Location</th><th>Standards and Regulations</th></tr>
<tr><td>EPA</td><td>

Standard for drinking water is 0.5 ppb.
Standard for eating the fish or shellfish and/or drinking the water from lakes or streams contaminated with PCBs is 0.17ppt. This is due to possible adverse human health effects resulting from bioaccumulation of PCBs.
Industry is required to notify the National Response Center whenever 1 pound or more of PCBs have been released into the environment.

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<tr><td>FDA</td><td>
<table>
<tr><th>Food source</th><th>Standard</th></tr>
<tr><td>Infant and junior foods</td><td>0.2 ppm</td></tr>
<tr><td>Eggs</td><td>0.3 ppm</td></tr>
<tr><td>Milk and other dairy products (fat basis)</td><td>1.5 ppm</td></tr>
<tr><td>Fish and shellfish (edible portions)</td><td>2 ppm</td></tr>
<tr><td>Poultry and red meat (fat basis)</td><td>3 ppm</td></tr>
</table>
</td></tr>
<tr><td>OSHA</td><td>Worker inhalation limit over a period of 8 hours for 5 days per week.
<table>
<tr><td>42% chlorine PCBs</td><td>1 milligram per cubic meter of air (1 mg/m^3 = 1 ppb)</td></tr>
<tr><td>54% chlorine PCBs</td><td>0.5 mg/m^3 of air (0.5 ppb)</td></tr>
</table>
</td></tr>
<tr><td>NIOSH</td><td>Workers should not breathe air containing 42% or 54% chlorine PCB levels higher than 1 microgram per cubic meter of air (1 $\mu g/m^3$ = 1 ppt) for a 10-hour workday in a 40-hour workweek.</td></tr>
</table>

ppb = parts per billion
ppm = parts per million
ppt = parts per trillion

What are the minimal risk levels for exposure to PCBs?

An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.

Route	Duration	Risk Level
Inhalation	Acute (1–14 days)	X
	Intermediate (15–364 days)	X
	Chronic (365 days or more)	X
Oral	Acute (1–14 days)	X
	Intermediate (15–364 days)	0.03 µg/kg/day (0.03 ppb/day)
	Chronic (365 days or more)	0.02 µg/kg/day (0.02 ppb/day)

ppb = parts per billion

What are the most important or common mediating factors?

Factors determining the severity of the health effects from exposure to PCBs

Factor	Influences the severity of health effects
Type of exposure, i.e. occupational or environmental	Exposure to different mixtures PCBs are a group of 209 synthetic organic compounds
Dose	Exposure below 0.02 µg/kg/day (0.02 ppb/day) is not expected to pose significant health risks
Duration of exposure	• Acute (1–14 days) • Intermediate (15–364 days) • Chronic (365 days or more)
Route of exposure	• Inhalation • Oral • Dermal contact
Age at time of exposure	Exposure during pregnancy, infancy, and the early years poses the greatest risk
Health of the person exposed	No specific disease or health condition is associated with increased risk

ppb = parts per billion

How is exposure to PCBs managed and treated?

No specific treatment for PCB toxicity is currently available. However, decontamination and supportive treatment are advised.		
Type of exposure treatment	**Management**	**Treatment**
Acute	**Inhalation exposure** • Move patient from the toxic environment to fresh air. • Monitor for respiratory distress **Dermal exposure** • Post-contamination washing cannot be assumed to remove PCBs **Oral exposure** • In nearly all cases, ingestion of PCBs would not be recognized until long after gastric decontamination would be of any value.	**Inhalation exposure** • Administer 100% humidified supplemental oxygen **Dermal exposure** • No effective treatment **Oral exposure** • No effective treatment

How does the body eliminate PCBs?

- The human body breaks down (metabolizes) PCBs; however, the process is very slow.
- PCBs are cumulative poisons.
- The dose to which people are normally exposed is generally low; however, the risk is increased because PCBs accumulate in the body.
- The rate by which PCBs metabolize varies by individual.

Is there a test to see if my child or I have been exposed to PCBs?

There are tests to determine whether PCBs are in the blood, body fat, and breast milk. These are not regular or routine clinical tests, such as the one for cholesterol, but could be ordered by a doctor to detect PCBs in people exposed to them in the environment and at work.

Media	**Tests for**
Blood	PCBs or its metabolites
Breast milk	PCBs or its metabolites
Adipose tissue	PCBs or its metabolites

Current Research Needs:

- Dose-response data in animals for acute- and intermediate-duration oral exposures.
- Biodegradation of PCBs in water; bioavailability of PCBs in air, water, and soil.
- Dose-response data in animals for acute- and intermediate-duration inhalation exposures. The intermediate-duration study should include extended reproductive organ histopathology.
- Potential candidate for subregistry of exposed persons.
- Additional information may be found in the ATSDR Toxicological Profile for Polychlorinated Biphenyls and the ATSDR Substance Specific Priority Data Needs.

For more information:

ATSDR. Toxicological Profile for Polychlorinated Biphenyls. Atlanta: Agency for Toxic Substances and Disease Registry, 2000 November. Available at: www.atsdr.cdc.gov/toxprofiles/tp17.html.

ATSDR, Substance Specific Priority Data Needs, Atlanta: Agency for Toxic Substances and Disease Registry, 2006 March. Available at: www.atsdr.cdc.gov/pdns/index.html.

EPA. Polychlorinated Biphenyls Home Page. Washington, DC: Environmental Protection Agency. 2006 February 15. Available at: www.epa.gov/opptintr/pcb/.

EPA. Technical factsheet on polychlorinated biphenyls. Washington, DC: Environmental Protection Agency. 2006 February 21. Available at: www.epa.gov/safewater/dwh/t-soc/pcbs.html.

CDC. Third national report on human exposure to environmental chemicals. Atlanta: Centers for Disease Control and Prevention. 2005 July 21. Available at: www.cdc.gov/exposurereport/.

For more information, contact:

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