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Memorandum

Date:	February 26, 2024
To:	North Carolina State University
From:	Chris Saranko, Ph.D., DABT, Geosyntec Consultants of NC, P.C.
Subject:	National PCB Environmental Occurrence and Health Effects Overview

Introduction

This memorandum summarizes information about poly-chlorinated biphenyl (PCB) use, presence in the built and natural environments, pathways to human exposure, and adverse health effects that have been reported to be associated with exposures to PCBs in scientific literature. This information comes primarily from publicly available reports prepared by regulatory or public health agencies including the United States Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease Registry (ATSDR), and the National Toxicology Program (NTP). These documents include:

- *PCBs in Building Materials—Questions & Answers* (USEPA, 2015)
- *Polychlorinated Biphenyls – ToxFAQs* (ATSDR, 2014)
- *Report on Carcinogens, 15th Edition – PCBs Substance Profile* (NTP, 2015)

What are PCBs?

PCBs are a class of synthetic chemicals that were manufactured in the U.S. from the late 1920s to 1977 and used in a wide range of commercial and industrial applications. There are 209 different PCB compounds, called congeners, each of which contains from 1 to 10 chlorine atoms. Most of the PCBs manufactured in the United States were marketed as complex mixtures of congeners under the trade name Aroclor. Aroclors are generally identified by a four-digit numbering code in which the first two digits indicate the type of mixture and the last two digits indicate the approximate percentage of chlorine by weight in the mixture (for example, Aroclor-1262 is 62% chlorine by weight). PCB congeners with higher molecular weights, such as those comprising Aroclor-1260, Aroclor-1262 and Aroclor-1268, have very low volatility and therefore, are not

expected to be present in air as a gas. Their presence in an air sample would most likely be tied to dust particles. PCBs were predominantly used as coolants and lubricants in electrical equipment such as capacitators and transformers due to their non-flammability, chemical stability, high boiling point, and electrical insulation properties. PCB manufacturing was discontinued in the U.S. in 1977 because of concerns about environmental persistence and potential carcinogenicity (ATSDR, 2014), and they were banned in the U.S. in 1979.

During their period of production, PCBs entered the environment via accidental spills, leaks, fires, disposal of PCB-containing products, and manufacturing processes. PCBs are still entering the environment today through runoff from urban areas where residual PCB contamination is more prevalent, as well as improper land disposal of PCB-containing products. PCBs do not readily break down in the environment and can accumulate in aquatic and terrestrial food chains.

How Were PCBs Used in Building Materials?

Common materials that contained PCBs used in schools and other buildings built or renovated between about 1950 and 1979 include caulking, paints, mastics and other adhesives, fireproofing materials, and in the manufacture of some ceiling tiles and acoustic boards, and a variety of other products. PCBs may also be present in fluorescent light ballasts manufactured before 1979 (EPA, 2014).

How Do People Get Exposed to PCBs?

PCBs are persistent in the environment and can migrate between soil, water, and air (ATSDR, 2000). Once in the environment, PCBs can accumulate in aquatic and terrestrial food chains. Fish and marine mammals, particularly top predators, can accumulate PCBs at concentrations thousands of times greater than environmental concentrations. The ability of PCBs to accumulate in the food chain makes dietary sources a predominant route of exposure to humans. Common food items such as fish, meat and dairy products are the main dietary sources of PCBs, while drinking water is generally not considered to be a significant pathway for exposure. Some dietary supplements containing fish oils have also been identified as containing PCBs (ATSDR, 2000).

Dietary intake and inhalation are generally considered to be the most significant pathways of exposure to PCBs in the general population, although PCB concentrations in food have decreased over time. In a study published in 2021, EPA scientists estimated population-level exposures to PCBs via indoor and outdoor air, indoor dust, soil, and total dietary intake. The results suggested that dietary intake contributed 88% of total PCB exposures, while indoor inhalation contributed 11% of total PCB exposures (Weitekamp et al. 2021).

Together, these sources of PCBs generally result in background exposures that are measurable but below the EPA's "reference dose" – or the amount of PCB exposure that EPA does not believe will cause harm (EPA, 2015). Indoor and outdoor air typically contain small amounts of PCBs. Most of the dietary intake comes from consumption of fish/seafood, meat, and dairy products. Some population groups or individuals with high fish/seafood consumption may experience higher dietary intake of PCBs than the general public. The U.S. Food and Drug Administration (FDA) recognizes PCBs as an unavoidable, widespread, environmental contaminant and has set temporary food tolerances for PCBs ranging from 0.2 to 3.0 ppm and a tolerance of 10 ppm in paper packaging in direct contact with food. 21 C.F.R. § 109.30(a).

PCB Health Effects

The health effects of exposure to PCBs have been studied in epidemiological and animal studies. Some studies of workers indicate that exposure to high concentrations of PCBs were associated with certain kinds of cancer in humans. The strength of evidence for such associations is stronger for melanoma and cancers of the liver and biliary tract, and weaker for breast cancer and non-Hodgkins lymphoma (AIHA, 2013). Rats that were fed diets containing high levels of PCBs for two years developed liver cancer. The NTP and EPA have concluded that PCBs may be human carcinogens based on sufficient evidence of carcinogenicity in studies with experimental animals and limited evidence of carcinogenicity in humans (NTP, 2015).

With respect to non-cancer health effects, workers exposed to high concentrations of PCBs in occupational settings have been shown to lead to possible liver damage, dermal lesions, and respiratory problems, while low level environmental exposures still need further research (ATSDR, 2014). Animal studies have found PCBs to induce a wide range of adverse health outcomes including, body weight loss, immunosuppressive effects, neurotoxicity, and reproductive and developmental toxicity (ATSDR, 2014). A more detailed summary of the health effects from PCB exposures is provided in ATSDR's *Toxicological Profile for Polychlorinated Biphenyls (PCBs)*, which compiles human and animal studies and reviews the toxicological mechanisms of PCBs (ATSDR, 2000).

References

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