APPENDIX B. TOXICOLOGICAL PROFILE FOR POLYCHLORINATED BIPHENYLS (PCBS)

Appendix B. Toxicological Profile for Polychlorinated Biphenyls (PCBs)

Although the production and use of PCBs were banned in this country in 1979, this chemical group is extremely persistent in the environment and bioaccumulates through the food chain (EPA 2000). There is evidence that some dioxin-like PCB congeners, which are assumed to be the most toxic, preferentially accumulate in organisms higher on the food chain, including humans. As a result, the composition of PCB mixtures in fish tissue may differ significantly from the environmental PCB source. Often the mixtures of interest are not those that have been used in studies of laboratory animals to determine toxicity (EPA 2000).

Pharmacokinetics

PCBs are absorbed through the gastrointestinal tract and distributed throughout the body, although the highest accumulation is typically in lipid-rich tissues. Human milk may contain relatively elevated PCB concentrations due to its high fat content (ATSDR 2000).

The retention of PCBs in fatty tissues is linked to the degree of chlorination and also to the position of the chlorine atoms in the biphenyl ring. In general, more chlorinated congeners persist for longer periods of time. In occupationally exposed individuals, less chlorinated congeners had half-lives between 1 and 6 years, while more chlorinated congeners had half-lives ranging from 8 to 24 years (ATSDR 2000). In subjects who consumed PCB-contaminated rice in Taiwan, the half-lives of several PCBs ranged from 3 to 24 months (EPA 2000).

Acute toxicity

Studies in animals have shown that exposure to very high doses of PCBs can cause death. However, doses of such magnitude are unlikely in environmental exposures and current industrial settings. There have been no reports of deaths in humans after exposure to PCBs even where exposures were much higher than those typically identified with environmental exposures (ATSDR 2000).

Chronic toxicity

Numerous effects have been documented in animal studies including hepatic, GI, hematological, dermal, body weight, endocrine, immunological, neurological, reproductive, developmental, and liver cancer (ATSDR 2000). Evidence of chronic effects in humans is not nearly as definitive. Several studies in humans have suggested that PCB exposure, particularly via in utero exposure through maternal fish consumption, may cause adverse effects in children and in developing fetuses (ATSDR 2000). Neurobehavioral effects in such children have been documented by Fein et al. (1984), Jacobson and Jacobson (1996, 1997), and Schantz (1996). Over intermediate durations (i.e., less than 10% of an organism's lifetime), learning problems have been

noted in monkeys fed PCB mixtures similar in composition to human breast milk (ATSDR 2000).

EPA has derived an **RfD of 2×10^{-5} mg/kg-day** for Aroclor 1254. The RfD was based on a LOAEL of 0.005 mg/kg-day for ocular and immunological effects in monkeys. Uncertainty factors of 10 for sensitive individuals, 3 for extrapolation from monkeys to humans, 3 for extrapolation from a subchronic exposure to a chronic RfD, and 3 for use of a minimal LOAEL were applied by EPA, resulting in a total uncertainty factor of 300. EPA's overall confidence in the RfD is rated as medium, based on medium confidence levels for both the primary study and the supporting database.

Carcinogenicity

PCBs are classified by EPA as Class B2, probable human carcinogens. This designation is based on studies that have found liver tumors in rats exposed to Aroclors 1260, 1254, 1253, and 1016. Human epidemiological studies of PCBs have not yielded conclusive results (Silberhorn et al. 1990).

EPA has developed a range of slope factors for PCBs (EPA 1996). Using information on environmental processes, they have provided guidance for choosing an appropriate slope factor based on the class of the mixture and the exposure pathway. Because bioaccumulated PCBs appear to be more toxic and more persistent in the body than commercial PCBs, the upper bound slope factor associated with high risk and persistence (**2.0 per mg/kg-d**) was used in this HHRA.

When assessing PCB mixtures, it is important to recognize that both dioxin-like and non-dioxin-like modes of action contribute to overall PCB toxicity. It is possible that concentrations of dioxin-like congeners are increased in an environmental mixture. When congener concentrations are available, the mixture-based approach based on Aroclor analyses can be supplemented by analysis of dioxin TEQs to evaluate dioxin-like toxicity. In that analysis, the dioxin slope factor (150,000 kg-day/mg) is used. In some cases, the magnitude of the dioxin slope factor results in PCB dioxin-like congeners contributing the majority of the risk.

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