Use of PCBs at World War II Manufacturing Sites

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Introduction

Companies responding to claims by the U.S. Environmental Protection Agency (EPA) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA"), the Superfund statute, may be able to seek contribution from the federal government because of federal ownership or operation of industrial and manufacturing facilities and equipment during World War II (WWII) [1]. Although polychlorinated biphenyls (PCBs) entered into commerce in the early 1930s [2], they were most widely used in the 1960s, and thus disputes sometimes center on the degree to which PCBs were used and released into the environment during the WWII manufacturing era (roughly 1940 to 1945). Historical records are often missing or ambiguous regarding the uses of PCBs in WWII manufacturing. The purpose of this paper is to provide examples of documented uses of PCBs at certain WWII manufacturing facilities and their potential pathways into the environment.

Materials and methods

We conducted historical research for indications of PCB use at various WWII manufacturing facilities. Facilities representing four different manufacturing operations—a cross-section of manufacturing—are discussed: a shipyard, a heavy duty manufacturing plant (Company A - confidential), an electrical wire and cable company, and two ballistic plants.

Results and discussion

Shipyards

Contamination of river and harbor sediments are often associated with past activities at WWII shipyards. Many naval shipyards are now well-known Superfund sites such as Hunters Point (San Francisco), Portsmouth (Kittery, Maine), Norfolk (Virginia), and Puget Sound (Bremerton, Washington). Studies of PCBs in older US Navy ships that have been scrapped have shown that PCBs were present in cable insulation, paints, lubricants, bulkhead insulation, rubber products, and ventilation gaskets [3]. The ex-USS Oriskany, an aircraft carrier built in the mid-1940s, contained about 644 pounds of PCBs, with 94% of the PCB mass in the electrical cable insulation [3]. Liquid PCBs could have been used on board in transformers and hydraulic oils; however, many of the WWII vintage ships had been retrofitted in the 1950s or 60s, so PCB containing materials could have been added in the post-war period.

The uncertain timing of the use of PCB materials thus makes it more difficult to claim that PCB-containing products and materials were actually used during the original construction in the 1940s. Thus, site-specific research is needed to evaluate whether PCBs were used and to what extent they may have been released into the environment during the war years. We will use the former Todd Shipyard in Tacoma, Washington (Figure 1), to illustrate the use of PCB containing materials in WWII shipbuilding.

Paint: Patent records [4] indicated that PCBs were likely used as plasticizing agents in "cold plastic antifouling" paint. This paint was used at the Todd Shipyard [5] during the timeframe of interest.

Cable insulation: The Halowax coating on cable insulation, containing up to 20% PCBs, was "used in considerable amounts on ships" [6]. As shipbuilding expanded enormously with the World Wars, "cable rash" or "Halowax acne" was observed in shipyard workers as a result of exposure to dust generated during skinning of the wire [6]. The Anaconda Wire and Cable Co. (AWC) manufactured Halowax insulated wiring and cables (discussed later) during WWII for the US Navy [7], who used PCBs to fireproof the wiring. A cable spool labeled "Anaconda" can be seen in a 1942 photograph taken at Todd Shipyard (Figure 2).

Dielectric fluids: PCBs were likely used in transformers and capacitors located on wooden piers at the shipyard. This was indicated by a U.S. Navy fire inspection that noted the fire hazard of transformers boiling over unless the dielectric fluids were switched to non-combustible fluids [8].

Pathway to sediments: Historical facility records and plans provided information on pathways linking the potential PCB sources to contaminated sediments. In this case, paint buckets were cleaned and wires were skinned adjacent to the berths above the PCB hot spots in the sediment (Figure 3). Transformer houses were also located on these same piers. Both provided pathways for the release of PCBs from World War II-era shipbuilding to adjacent sediments. The results of this investigation assisted the parties in reaching an equitable settlement of remedial cost contributions.

Electric Cable Manufacturing

The Anaconda Wire Company (AWC) in Hastings on Hudson, NY, produced about one fourth of the cable used by the US Navy during WWII [9]. AWC manufactured copper wire, lead-covered cable, high-voltage cable, and insulated wire. Beginning in the late-1930s, PCB (Aroclor) mixtures were used to impregnate paper- and asbestos-wrapped cable before the outer sheathing was applied [10]. The site has been remediated.

Heavy Manufacturing Site

Research conducted at a confidential site (Company A) yielded documentation of PCB use during the WWII production period. Specifically, records indicated that at least 21 Pyranol (PCB-containing) transformers were installed in 1940 under an Emergency Plant Facilities (EPF) Contract. PCB containing transformers were generally used where flammability was a concern. As described in the U.S. Department of Army (DOA) 1949 manual for electrical substations [11]: "Liquid dielectrics are used in transformers to obtain high impulse strength and effective cooling. Mineral oil and askarel (PCB-containing dielectric fluid) are commonly used, the latter being a noninflammable, nonexplosive, synthetic liquid… Askarel is used in specially built transformers which make vaults for fire protection and safety unnecessary."

PCB leakage from the buried vaults with these WWII-era transformers was identified as a major transport pathway via storm drainage systems to an adjacent industrial waterway that required sediment remediation for PCBs.

Ballistics Manufacturing

Several references indicate that PCBs were used in the manufacturing of artillery shells during WWII. One company "…used Aroclor as a heat transfer medium in maintaining a molten lead bath in which they soaked 14 inch armour piercing projectiles" [12]. A cartridge manufacturer was noted as requiring large quantities of Aroclor for transformers: "[A]s an example of the amounts of Aroclor needed under the defense program, the situation of the Western Cartridge Company plant now under construction in St. Louis, Missouri is cited: [T]ransformers in this plant will require approximately 228,999 pounds of Aroclor in their manufacture" [13].

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References

1. Roth SN, Rapp EP and Littlejohn DA (2003) "The Environmental Legacy of World War II: Recovering CERCLA Costs from the U.S. Government," *ACCA Docket 21*, **8** 42–59
2. Erickson MD and Kaley RG (2011) "Applications of polychlorinated biphenyls," *Environ. Sci. Pollut. Res.* **18**(2) 135–151
3. CACI (2006) "Final report, polychlorinated biphenyls (PCB) source term estimates for ex-ORISKANY (CVA 34)," Rev. 5, Prepared for Program Executive Office (Ships), Navy Inactive Ships Program (PMS 333), Washington, DC. CACI International Inc, Fairfax, VA.
4. Pitre AS and Saroyan JR (1947) "Surface protecting materials and methods for making the same," US Patent Office No. 2,579,60. Continuation in part of Patent Application 496,656 filed July 29, 1943.
5. U.S. Navy (1943) "Industrial health & safety survey of Seattle-Tacoma Shipbuilding Corp, Tacoma, Washington." July 22−31, 1943.

6. Good CK and Pensky N, (1943) “Halowax acne (‘cable rash’), a cutaneous eruption in marine electricians due to certain chlorinated naphthalenes and diphenyls,” *Arch. Dermatol. Syphilol.* **48**(3) 251−257.
7. Atlantic Richfield Company (2017) “One River Street and World War II.” Available at: http://oneriverstreet.com/site/ww2.php. Accessed May10, 2017.
8. U.S. Navy (1942) “Seattle-Tacoma Shipbuilding Cor. (Tacoma Division) Tacoma, Washington—Internal security recommendations,” Navy Department, Bureau of Ships, Washington, D.C.
9. Cashin Associates (2002) “Draft report, local waterfront revitalization program, The Village of Hastingson-Hudson.” Prepared by Cashin Associates, Hauppauge, New York
10. NYSDEC (2004) “Record of Decision, Harbor at Hastings Site, Operable Unit No. 1, Village of Hastings-on-Hudson,” Westchester County, New York, Site Number 3-60-022
11. DOA (1949) “Electrical facilities, substations, repairs and utilities,” Technical Manual TM5-680F (changes to Section X - insulating liquids), Department of the Army, Washington, D.C. 9 pp.
12. Monsanto Chemical Company (1944) Salesman Manual: Aroclor, October 1, 1944
13. Monsanto Chemical Company (1941) Letter to the Secretary of War and the Advisory Commission to the Council of National defense. July 16, 1941.

Figure 1. Location of the former Todd Shipyard in Tacoma, Washington

Figure 2. Cable and/or wire spools showing Anaconda label, 1942 photograph at Todd Shipyard.

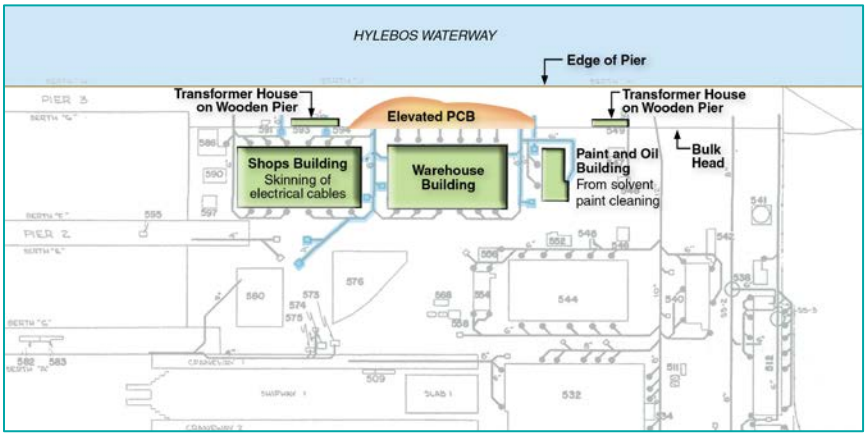

Figure 3. Schematic showing proximity of PCB sources to the PCB sediment hotspot located beneath a wooden pier on the north side of the former Todd Shipyard. Halowax particles from cable skinning and solvent washing of PCB-containing paint may have been transported via storm drains (shown in blue) into the waterway. Another likely source would be leaks and boiling over of dielectric fluid from the transformers on the pier.