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THE THREAT OF PCB

***Environmentalists wonder about this wonder compound, "around" since 1929 and hard to get rid of. An in-depth article by Hugh Grambau. Reprinted from the June 1976 issue of* Lakeland Boating. *Copyright © 1976* Lakeland Boating.**

It seemed like such a good idea in 1929—a new man-made miracle fluid, so stable that under extreme temperature and pressure it would not break down or boil away. A non-conductor of electricity and non-flammable, this gift of modern chemistry would revolutionize the electric power industry and find a thousand other manufacturing uses from ironing board covers to silo sealants.

Today, the Great Lakes states are banning its use, in view of disturbing evidence that the liquid that promised miracles is threatening fish reproduction, making Great Lakes salmon and trout dangerous to eat, and possibly threatening people's health. Commercial fishing in the Hudson river was recently banned and the once rosy prospects for a thriving commercial fishery in the Great Lakes have turned gloomy. The worst part is that the problem is so widespread and long lasting that our belated efforts to ban it from the environment may not improve the situation for many decades.

The liquid is called polychlorinated biphenyl: PCB for short. It was relatively easy to produce—you started with those versatile hydrocarbons, added some chlorine atoms and that was all. A close cousin, DDT, would later find great favor as a pesticide. Another relation, plastic, would touch every part of man's day-to-day life.

There were some little irritations. Factory workers where PCB was produced developed a troublesome skin condition, but this was a minor thing compared to the promise that PCB held for the future. After a slow beginning, that promise began to be fulfilled after the 2nd world war. Industry discovered that high temperature heaters could be built with thinner, less expensive parts when they circulated PCB as a heat transfer medium, instead of superheated water or steam. In the automobile and metal refinishing industries, PCB proved to be an excellent hydraulic fluid impervious to high pressure and heat. As a dielectric (non-conducting) fluid in power transformers, PCB was soon replacing mineral oil due to its superior fire-retarding qualities. The equally safe dry transformers were large and clumsy to install in comparison.

In the meantime, it was discovered that when added to resins and rubber, PCB made them more flexible and workable. In the form as a plastic, PCB was added to a myriad of diverse products—paints, waterproof fabrics, ironing board covers, wire coatings, printing inks, "colorless" carbon paper, copying paper, plastics, rubber products, glue, cutting oils and sealers for joints to keep out moisture, dust or

Today, PCB is found in the environment. And because of its stability, the very stability that made it so attractive for industrial use makes it unattractive

When a product containing PCB is discarded, the problem is compounded. Burning PCB at high temperatures PCB sticks to particles in the air, and, in the form of fallout and made into new products, including wrapping paper. In addition, the practice of using PCB as a heat transfer medium and PCB hydraulic systems have proved to be notorious for leaks into streams and sewage systems.

PCB biodegrades even more slowly than DDT, which persists 15 years or more in the environment. Certain varieties have a molecular structure so strong that natural enzyme action is unable to break it down at all.

"It's something that doesn't exist in nature, and nature has no way of dealing with it," says Steve Buda of the Michigan water resource commission. To destroy PCB you must incinerate it at a temperature up to 2,700° F.

Of the 80 million pounds of PCB sold at the height of production in the US in 1970, about 40% was used for plasticizers, heat transfer materials, hydraulic fluid, and various other "open-ended" applications. The remaining 60% was used by the power industry in the manufacture of transformers and capacitors, the so-called "close-ended" applications. The difference between the 2 is supposedly that leaks to the environment are less

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former or power the fluid just sits system where it is leaky pipes or used as product. The trouble careless disposal of ming electrical com- obsolete ballast con- very fluorescent light idental losses from and storage facilities, all the time.

John, Hea- rvivor of the toxic Michigan's dept. of imates that there er capacitors in

around 26,000, and 32,000, and hands of smaller se," he reports. "I nth of one % explode ye Hesse. The explosion is by an internal arc short-circuiting the unit.

Some of them rupture on poles and rooftops, spreading PCB over soil, shrubbery, and into ponds and streams. Edison reported 25 ruptures last year. Each capacitor contains from one to 2 gallons of PCB and each gallon weighs about 12 pounds. In a given year, as much as 1,000 pounds of PCB may be lost through such accidents and the cost of adequate clean-up can be prohibitive. Depending on the nature of the spill, collection and disposal of contaminated soil, brush, and water from a single burst capacitor containing less than 2 gallons of PCB can run as high as $3,000.

But even larger quantities get into the environment. In 1971, one power company used 562,000 pounds of PCB with losses of 300 pounds from burst capacitors and 12,000 pounds from salvaged capacitors that had to be replaced. Most liquid from salvaged capacitors has been disposed of through waste haulers, who in turn get rid of it in several ways—using it to control dust on roads, mixing it with oils as a fuel in low-temperature boilers, and treating and discharging it to local sewage systems. Last summer, the EPA discovered that 2 General Electric plants in New York were regularly discharging at least 30 pounds of PCB into the Hudson river every day. So, the "close-

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ended" systems aren't so closed after all.

In 1970, after the government began several studies on the effects of PCB in the environment, Monsanto Chemical, the only US producer of PCB, "voluntarily" instituted a ban on sales for open-ended uses. Such sales were phased out over 2 years, ending in September 1972. The rationale for the continued use of PCB for electrical applications is that no substitute fluid exists which can equal its fire-retarding properties. Electrical codes require PCB transformers in congested areas and in buildings. Where the hazard is not great, mineral oil can be used instead. Several companies are working on substitutes that will meet acceptable safety standards. In January, Monsanto announced its intention to discontinue all sales as soon as a substitute is marketed. Until then, the company will continue to turn out 45 million pounds each year.

Japan implemented a total ban on PCB by September 1973, following the poisoning in 1968 of more than 1,000 persons by rice oil contaminated with PCB. Their symptoms became known as "yusho" (oil) disease.

When asked why Japan could stop any more PCB from going into her environment, while we can't, Monsanto replies that "the Japanese power distribution industry, less advanced than the US technically, had never actually gotten around to taking advantage of fire-resistant transformers to the extent they have been used in this country. Most of their transformers were either using mineral oil or were dry-type units."

Without getting into the merits of being "technically advanced" or "taking advantage" of PCB transformers, it's clear that the widespread use of PCB in the power industry poses a difficult economic problem. While safety standards could be met by dry transformers, they are bulky and would cost many millions of dollars to install. Initially, the cost would be borne by utilities and industry, but eventually the public would pay through higher rates and prices.

Would it have been worth the cost to halt the use of PCB as expeditiously as Japan? It's a hard question to answer, since it involves weighing uncertain but potentially disastrous environmental consequences against concrete dollars.

Unfortunately, the levels of PCB discovered in Great Lakes fish have gone higher since the 1972 partial ban on sales. Monsanto maintains that improved detection and increased surveillance have simply uncovered the existence of PCB used in years past. DNR experts fear that despite the efforts taken, dangerous amounts of PCB are still entering the environment from electrical uses.

It is a difficult problem because a small amount of PCB in the water can create a big threat to the fish that live in it. PCB is partially soluble in water, but very soluble in fat. Fish, especially the fatty varieties of trout, coho, and chinook found in Lake Michigan and Lake Superior, sop up PCB in the water around them and concentrate it in the fatty tissues of their bodies at levels as much as 100,000 to 200,000 times greater than surrounding water. The process is called bioconcentration. It means that while the quantity of PCB that escapes into the environment is small compared to other pollutants (such as phosphate fertilizers used in agriculture, for example), its impact can be devastating.

The purest of all the Great Lakes is Superior. The PCB level there has been measured at less than one part per trillion. And yet lake trout have been discovered off Isle Royale which exceed the food and drug administration's "safe" limit of 5.0 parts per million. That limit was set in 1969, after it was discovered that PCB caused problems in animals and human beings similar to those caused by DDT. Lake trout in Lake Michigan often exceed the limit by 2 to 3 times, and people are warned not to eat coho salmon they catch more than once a week. In February, the health planning commission of the state of New York issued a report recommending that eel and salmon taken from Lake Ontario not be eaten at all.

McGRAW-EDISON DROPS P.C.B.
The manufacturer of power capacitors began using Edisol, developed jointly with Dow Chemical, as a substitute for PCB November 1. The Edisol-insulated units cost about 25% more than those using PCB, according to the Detroit *Free Press*.

Commercial fishing, too, is limited by PCBs, since fish above the 5 parts per million limit cannot be sold for human consumption. PCB is the reason you can't buy Michigan coho salmon at the grocery store. Millions of pounds of surplus salmon from Lake Michigan are buried each year. An ironic twist is that the Michigan Indians who, up to now have exercised their disputed right to unlimited fishing in Lake Superior, may not be able to sell their catch if the PCB levels there continue to rise.

Even the fish stocking programs that promised to bring back fishing in all the Great Lakes and the Detroit river appear threatened.

"We fear that the accumulation of PCB in fish tissues may not only be a potential threat to humans who may eat large quantities of contaminated fish, but also threaten the fish themselves in terms of reproduction problems," states the DNR's John Hesse.

The levels of PCB concentrated in fish eggs are higher than in the fish themselves. In studies of Atlantic salmon, levels of 0.5 parts per million in eggs create reproduction problems. PCB levels of 2.7 parts per million in rainbow trout eggs caused high mortality rates in the newly hatched fry. In Lake Michigan salmon eggs, the level average is about 10 parts per million. DNR officials are carefully monitoring all hatcheries.

Fish-eating birds also have been adversely affected. Populations of ringbilled gulls, herring gulls, caspian terns, common terns and double-crested cormorants in lakes Erie, Ontario, and Huron have been found with high concentrations of PCB. A pattern of reproductive failure including high egg loss during incubation, mechanical breakage of eggs due to thin shells, and embryo and chick mortality has become apparent. When PCB was fed to laying pheasant hens and ring neck doves, egg production, hatchability, and viability decreased. The symptoms of PCB poisoning in birds are sluggishness and body tremors, similar to those caused by DDT.

Mink ranchers who fed their animals coho salmon from Lake Michigan containing 5.0 parts per million discovered that *all* reproduction was halted. With smaller quantities of PCB in the diet, the minks conceived, but had many stillborn young. After the accidents on the mink ranches, research was conducted in which mink were fed 10 parts per million of PCB. 7 out of 10 died. In other research, PCB has been shown to cause liver cancers in rats.

In tests with rhesus monkeys at the University of Wisconsin, females fed a diet containing 2.5 parts PCB per million suffered from swelling around the head, loss of hair, redness of the skin, and acne-like lesions on the face and neck. They also had reduced conception rates and increased menstrual bleeding. On the basis of this data, Canada established a "safe" limit in fish for human consumption of 2 parts per million. It is rumored that the FDA is on the verge of following suit.

We don't know the effects of chronic exposure to low levels of PCB on humans, although tests on a cross-section of the american population in 1974 revealed that 40% of those tested had PCB levels above one pert per million in their fat tissues.

As in several other environmental disasters, Japan has unfortunately provided the only large sample of human guinea pigs other than factory workers. In the 1968 Yusho incident, a leaky heater contaminated a batch of rice oil with 2,000 to 3,000 parts PCB

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per million. Health officials estimated that the victims consumed between 0.5 and 2.0 grams of PCB. Their clinical symptoms included systemic gastrointestinal problems, abdominal pain, acne-form eruptions on the skin accompanied by accentuated hair follicles, red blotches on the limbs, and a persistent feeling of weakness. Children showed decreased growth rates. Babies born to pregnant women who ate the contaminated oil had unusually grayish, dark brown stained skin, and in half of the cases, had darkly pigmented gums and nails. All the babies had excessive eye discharge. Although many of the victims improved after several years, about half showed no change and there appears to be no cure for the disease.

Humans can take PCB into their bodies through digestion, inhalation, and absorption through the skin and mucuous membranes. It is present in our drinking water and sometimes contaminated food other than fish. In 1970, the FDA identified milk contamination in Ohio, Georgia, and Florida which resulted from the use of a sealant containing PCB in silos. The sealant contaminated the grain, cows ate the grain, and PCB appeared in their milk. A similar incident occurred in Michigan last year, when 76 dairy herds were found to be contaminated. (The PBB problems were in addition to this.)

In factories, workers are often directly exposed to PCB compounds. Engineers in charge of a PCB heater in a Detroit automotive paint plant complain of symptoms similar to Yusho poisoning. Last summer, General Electric admitted that over the last 15 years 49 employees at plants in Hudson Falls and Fort Edward, New York, reported cases of allergic rashes, diagnosed as caused by contact with PCB.

Workers can also expose their wives and children. In 1933, it was not uncommon for whole families to get a severe skin disease called chloracne when the father worked in plants producing PCB. In a recent study of vacuum cleaner sweeping from the home of a worker exposed to PCB on the job, researchers found 180 parts per million, a high level.

We also breathe PCB. One major source to the atmosphere is the refuse dump, where PCB-containing papers and products are often burned. Transformers which contain PCB have vents that add vapors to the air and vaporization directly from paints, coatings, and plastics made with PCB has been reported. Later, the vaporized PCB returns to earth with rain or snow. Samples of snow in Wisconsin showed PCB levels greater than those of any stream flowing into Lake Michigan. The EPA has estimated that 80% of the PCB entering Lake Michigan in a given year came from the atmosphere.

Disposal of PCB presents a big problem; there simply aren't enough adequately equipped incinerators. Monsanto will handle pure PCB liquid for a price, but can't dispose of any solid waste, such as sawdust from factory floors or contaminated soil or brush.

The only alternative to incineration is disposal in a completely sealed landfill, so that no PCB can seep into ground water. But that, in turn, creates another occupational hazard. A study of refuse workers showed that 81% had PCB in their blood plasma, compared to only 11% of a control group.

PCB is going to keep entering the environment for years, even when production is finally discontinued. It is sticky. A 1972 japanese study shows that PCB adheres to the fingers of persons handling "carbonless" carbon papers and does not readily wash off. From factories, even with repeated flushings, measurable (if much reduced) levels of PCB are entering sewers and streams from heaters and hydraulic systems long since converted to other fluids. The same residue problem will plague the power industry when some new fluid replaces PCB in transformers and capacitors. Old stocks of papers, paints, and other PCB-containing products may not run out for decades.

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When PCB goes down a drain in a factory, it is not eliminated from the environment by sewage treatment. Secondary treatment removes about 50% from the water that enters rivers and lakes, tertiary treatment about 66%. What is removed from the water goes into sewer sludge, commonly disposed of by incineration (not necessarily at temperatures high enough to destroy PCB), spreading on agricultural land, or dumping in landfills. At present, there is no way to get rid of contaminated waste water that does not put PCB back into the environment.

There is one bright spot, though. The government of Canada and the province of Ontario, working with a canadian cement company, have pioneered a process of incinerating PCB in cement kilns. Not only is the PCB destroyed, but the amount of chemical additives usually needed to make cement is reduced, cutting costs to the manufacturer.

"The DNR is having informal discussions with the Peerless Cement Co. about such a setup in Michigan," reports John Hesse. "It would have the advantage of providing local disposal services which do not now exist."

In March, Michigan passed a bill banning all open-ended uses of PCB in the state. Indiana passed a carbon copy bill late last year. Continued use and sale for transformers and capacitors will be allowed until the director of the DNR rules that an acceptable substitute is available. The bill also includes labeling, reporting, and disposal requirements for continued use. Up until now, there have been no restrictions whatever on the use or disposal of PCB anywhere.

Other Great Lakes states are working on similar legislation. The states, led by Michigan, are clearly putting pressure on the federal government, which alone can act effectively to end the national PCB crisis. The environmental protection agency maintains that current statutes do not give it authority to ban the use of PCB nationwide, a point that conservationists contest. A bill which would clearly empower the EPA to take control of the situation, the toxic substances act, is currently languishing in congress.

Barry Commoner, the environmentalist, has pointed out that although environmental problems are usually an extension of occupational health problems, little is done until fish or birds start dying from the residues of substances that workers handle every day. In the case of PCB, he points out that by the end of world war II the dangers and need for strict controls were established from workers' experience. Yet no concern was expressed or research begun until 1966, when a swedish scientist found PCB in baltic fish and birds.

Had somebody in industry, labor, or government paid more attention to workers' ongoing job-related health problems, PCB might never have been allowed to permeate our environment. Today, amid talk of an epidemic of environmentally caused cancer, and other health problems, we can no longer afford to ignore the dangers of PCB. Nor can we avoid the unpleasant fact than many people, especially workers, have suffered permanent damage to their bodies and minds from toxic materials like PCB used in factories every day. But long-term damage to one's health is seldom recognized as an occupational injury, since compensation would have to be paid.

PCB is only one of numerous products of modern science and technology that has negative side effects never considered when we began their widespread manufacture and use.

In the case of PCB, the early warning signs were present, but we ignored them, in part because we couldn't recognize them, in part because we didn't *want* to recognize them. The lure of "progress" and profit overcame prudence.

—Hugh Grambau

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