

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Polychlorinated biphenyls (PCBs) have been used in the United States and elsewhere over the past 40 years, for many industrial and consumer applications. During the past three years evidence has accumulated to indicate that PCBs are widely dispersed throughout the environment and that they can have adverse ecological and toxicological effects.

The principal uses for PCB fluids are in the electrical industry. PCBs have superior cooling, insulating, and dielectric properties and hence are widely used in various electrical devices. Transformers and capacitors filled with PCBs can be used in inside locations where failures of oil-insulated equipment would present a potential danger to life and property. Because PCBs are relatively nonflammable, apparatus containing them is essentially free from the fire and explosion hazards associated with oil-insulated and oil-cooled electric devices. Stability at high temperatures is another major factor in the attractiveness of these compounds. The principal advantage of PCBs over substitutes is the relative freedom from flammability in some applications that previously had been plagued by serious fires. PCBs also give electrical equipment the critical advantages of reliability, long life, and compactness. PCB impregnated capacitors, for example, are markedly more reliable and long-lived, and 1/6 the size, 1/5 the weight, and 1/4 the cost of comparable oil impregnated capacitors. Small capacitors with PCBs have a use-life expectancy of 10 to 15 years, and large capacitors 20 to 25 years. PCBs in transformers are replaced only every 25 to 30 years.

PCBs have been discovered to have a widespread distribution in the environment, and some environmental occurrences have been associated with adverse effects on certain forms of animal life. Beginning in 1971, the Monsanto Company, the sole U. S. producer, has reported taking voluntary actions to reduce the volume of PCB production and to limit its distribution to industries concerned with the manufacture of electrical apparatus. Similar restrictions have been put into effect by statute in Sweden and voluntarily in Great Britain.

A large use of PCBs had been in carbonless duplicating paper. This use has been discontinued. The Food and Drug Administration and the food industry have increased their surveillance to assure that PCBs are not used in food plants, products, or packaging.

The task force has reviewed all of the available scientific information on various aspects of the PCB problem. It has found much data that it regards as inadequate and many questions that remain unanswered. But on the basis of available information, the task force concurs on the following findings, conclusions, and recommendations:



5. Housekeeping is particularly important in the manufacture, use, and disposal of PCBs. Under a program of limitation on the sale of PCBs, the electrical industry will continue to be the principal user of PCBs; it, as well as industries now holding inventories of PCBs, have a special responsibility for monitoring and controlling their wastes. In this connection, the Environmental Protection Agency will restrict industrial liquid discharges of PCBs from PCB users. To keep levels in fish as low as possible, and in any case below FDA's interim action level of 5 parts per million, concentrations in rivers or lakes from all sources should not exceed 0.01 parts per billion.

6. The use of PCBs should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCBs in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCBs to all except manufacturers of electrical transformers and capacitors.

Pending passage of the Toxic Substances Control Act, the Federal Government does not have the legal authority to impose restrictions corresponding to the actions reported by Monsanto. Although some Federal enforcement authority is available, the Federal Government does not have the authority to control PCBs at their source.

7. Most capacitors presumably have been disposed of in landfills. PCB containing material buried in soil is not expected to migrate but should remain in place. In the past, many fluids containing PCBs have been disposed of in sewers. More appropriate means of disposal such as high-temperature (at least 970°C) incineration must be used instead.

8. PCBs are manufactured in countries other than the United States. Importation of PCBs as a chemical or as a component in products remains legally possible because the Toxic Substances Control Act has not yet become law. Electrical products imported from abroad may contain PCBs. The task force looks to international agreements to bring about some multi-national understanding on the sale and use of PCBs globally. Importation of PCBs for uses other than those singled out in the present pattern of voluntary limitations should be avoided by users.

As an additional measure, the United States has asked the Organization for Economic Cooperation and Development (OECD) through its Environment Committee to make a special review of member states' national policies concerning PCBs and also to identify products moving in international trade which contain PCBs. OECD, whose membership includes all major Western industrialized states plus Japan and Australia, has been giving priority attention to the problem of PCBs over the past year.

9. More scientific information about PCBs is needed, and several Government agencies are seeking it through research. The task force recognizes that the scientific basis of much of our knowledge must be

production and sales figures for 1971 were roughly half of those for 1970, when these volumes were at their peak (Table 1 and Figures 1 and 2). Projections for 1972 indicate an even lower volume.

Prior to 1971, about 40 percent of the PCB material in the United States was used in applications where containment was difficult and losses into the environment were probable. These uses included plasticizers, hydraulic fluids and lubricants, surface coatings, inks, adhesives, pesticide extenders, and microencapsulation of dyes for carbonless duplicating paper. The remaining 60 percent of domestic sales was used mainly in electrical applications (transformers and capacitors). In 1971, this fraction is expected to have reached approximately 90 percent of the total use, only about half of the total use in 1970.

In terms of the grade or family of PCB manufactured, the lower chlorinated species have generally made up the majority of the products produced. From the figures in Table 1 it can be seen that Aroclor 1242 and grades with lower percentages of chlorination characteristically composed one half or more of the total production between 1963 and 1970.

The largest categories of use of PCBs have been in capacitors and transformers and in certain "plasticizer" applications including carbonless duplicating paper. A large percentage of the production of Aroclor 1242 went into these three categories of products. (2) The major uses for PCBs prior to 1970 (in the order of importance as a reflection of the volume of material used) were:

- Capacitors
- Plasticizer applications
- Transformer fluids
- Hydraulic fluids and lubricants
- Heat transfer fluids

II. CHEMICAL AND PHYSICAL PROPERTIES AND IMPURITIES

Chemical and Physical Properties of PCBs

Theoretically, there are 210 possible PCB compounds, but only about 100 are likely to occur in commercial products. The degree of chlorination determines the chemical and physical properties of the Aroclors; the first two digits of the numbered Aroclor represent the molecular type, the last two digits the average weight percent of chlorine. Their physical state thus varies from colorless, oily liquids to more viscous and increasingly darker liquids to, in the higher series, yellow and then black resins. The PCBs are not readily biodegradable. They resist breakdown by water, acids, and alkalis and have boiling points ranging from 278 to 475°C.

Analytical Techniques

Whereas in the past it was difficult to identify PCBs in the presence of other organochlorine compounds such as DDT and DDE, they can now be separated from interfering compounds and identified and measured by means of thin layer and gas liquid chromatography at levels less than 1 part

Electrical Uses

PCBs are used in fluids (known as askarels) for electrically insulating and cooling transformers when the transformers are used in or near buildings. Being virtually free of fire and explosion hazards, PCBs can be used where failures of oil-insulated transformers would present a potential danger to life and property. PCBs also are superior to oils in reliability, in making small equipment possible, and in assuring long life and reliability to equipment. Table 1 shows the flammability ratings of two PCBs compared to five other common materials.

Table 1

Underwriters' Laboratories Flammability Ratings

<u>Fluid</u>	<u>Flammability Rating</u>
Ether	100
Gasoline	90-100
Ethyl Alcohol	60-70
Kerosene (100° F.P.)	30-40
Mineral Oil	10-20
Aroclor 1242 and MCS 1016	2-3

PCBs are used in transformers wherever fire protection is particularly important--for about 5 percent of all transformers.

Most of these transformers are located inside public, commercial, or industrial buildings--or on the roof tops of, or in close proximity to, such buildings--and require no special enclosures other than those necessary to prevent accidental hazardous mechanical or electrical contact of persons with the equipment.

The amount of Aroclor used in various types of transformers ranges from 40 to 500 gallons (516 to 6,450 pounds) with an average of about 235 gallons (3,032 pounds). During 1968, the last complete "normal" year for the electrical industry, the total amount of PCBs used in new transformers or as replacement fluid was approximately 1.3 million gallons (8.4 thousand tons).

The only present alternatives to Aroclor-insulated transformers are mineral oil-insulated transformers or dry-type transformers (either those open to the atmosphere or those that are gas-filled and sealed). Mineral oils are the preferred fluids when fire does not create a hazard. Dry transformers also can be used when space is available to install them. Fluorocarbon liquids require a special transformer design.

PCBs are used in more than 90 percent of the electric utility (large power) type and smaller industrial type capacitors made today. They are needed for safety, reliability, and long life, and to achieve sizes compatible with equipment and installation requirements.

IV. OCCURRENCE, TRANSFER, AND CYCLING IN THE ENVIRONMENT

Given the diversity of uses of PCBs and their chemical characteristics (greater stability in the higher chlorine species), it is not surprising that the residues are widespread. While satisfactory quantitative estimates of the contribution of various pathways into the environment are not possible with existing data, there are enough data to be certain that PCBs do reach the environment at least from the following sources:

- Open burning or incomplete incineration (at usual temperatures) of solid wastes, municipal and industrial. Incineration at 2000°F or above for two seconds will destroy PCBs, but poorly operated incinerators or open burning may result in PCBs being released to the atmosphere unchanged.
- Vaporization from paints, coatings, plastics, etc. (Nisbet and Sarofim, 1) estimate that as much as 20 percent may be vaporized.
- Municipal and some industrial sewers (PCBs present in treated as well as untreated wastes).
- Accidental spills or improper wastes disposal practices.
- Formerly, direct application to the environment as ingredients of pesticides or as carriers for pesticides (such uses of PCBs are now prohibited).
- Dumping of sewage sludge, municipal and industrial solid waste, and dredge spoil at sea.
- Sewage sludges disposed of on land.
- Migration from surface coatings (paints, etc.) and packaging materials into foods and feeds.

Probably the largest amounts of PCBs circulating in the environment reach it through industrial and municipal discharges to inland and coastal waters.

The recommendation by the task force that "more scientific information about PCBs is needed" is illustrated by the sparsity of knowledge about PCBs in the environment. Only general statements can be made about how PCBs reach the environment, how they reach target organisms, and how much is present.

Nisbet and Sarofim (1) estimate that the total loss of PCBs into the U. S. environment over the last 40 years would approach 30,000 tons to the atmosphere, 60,000 tons to water and 300,000 tons to dumps. Of this total, remaining residues might be 20,000 tons from the air (which would be distributed on land or water), 30,000 tons in water, and perhaps 250,000 tons in dumps.

- PCB residues in milk have resulted from the use of PCB in certain coatings on the inside walls of silos, which, in turn, contaminated the dairy feed silage.
- The use of spent PCB transformer fluid as a herbicide spray vehicle allegedly contaminated dairy cattle grazing areas thereby causing residues in milk.
- The grinding of bakery products along with their PCB-containing wrappers for use as poultry feed is suspected to have caused contamination of fowl.

These incidents, as well as others during the past several years, represent localized sources of contamination. Federal, State, and industry actions prevented most of the contaminated foods from being marketed.

Food Packaging

A significant percentage of food paper packaging materials contains PCBs and has resulted in the migration of low levels to the packaged food. This source of food contamination was identified in 1971. The origin of PCBs in packaging materials is not fully understood. Recycled waste paper containing PCB carbonless "carbon" paper is the prime source of PCB in paperboard product. Virgin paper products, however, have also been shown to contain PCB residues, probably as a result of the paper manufacturing processes. Data on current production of food packaging materials indicate that the levels are decreasing and are controllable so that the potential for PCB contamination of packaged foods can be minimized.

Dietary Intake

National monitoring data, and in particular FDA's total diet studies, indicate that the human dietary intake of PCBs is of a low order. For example: the dietary intake expressed as mg/kg body weight/day, and based on food consumption approximately twice as high as the normal diet, was less than 0.0001 in FY 1971 and 0.0001 in the first-half of FY 1972. As a point of reference, from 1965 to 1970 dietary intake of DDT was 0.0007 mg/kg body weight/day. Other investigations further disclose that except for unavoidable background levels in certain foods, the PCB contamination of food can be significantly reduced or eliminated through appropriate controls.

Man and the Ecosystem

In air and water away from immediate sources of waste discharge, levels of PCBs are low -- a few micrograms per cubic meter (parts per trillion; ppt) in air and less than a part per billion (ppb) in fresh water; soil or bottom sediments contain a few parts per billion, up to several hundred parts per million (ppm) near some industrial outfalls; from tenths of a ppm to tens of ppm in fish and up to hundreds of ppm in some fish and birds near the top of the food chain. To illustrate these relationships, 1/8 of an inch is about