ENVIRONMENTAL PROTECTION AGENCY

[FRL 514-4]

PCB-CONTAINING WASTES (INDUSTRIAL FACILITIES)

Recommended Procedures for Disposal

On December 22, 1975, the Administrator of the Environmental Protection Agency announced an action plan of regulatory and administrative actions to help ensure that polychlorinated biphenyls currently in service do not enter the environment. One portion of that program includes investigation and recommendation of appropriate disposal procedures for *industrial users* of this family of chemicals or products containing them. The Agency is also evaluating the consumer waste disposal problem and may issue further guidance on that subject at a later time.

Purpose.—Pursuant to Section 204(b)(1) of the Solid Waste Disposal Act, as amended, the Administrator may issue advisory guidance and recommendations related to the disposal of waste materials. These recommended procedures do not have standard-setting or regulatory status, but represent the best information available on preferable disposal options for PCB-containing waste materials. The Agency plans to conduct studies to determine other options for treatment and disposal of PCB-containing wastes (including incineration of capacitors containing PCB liquids) during calendar year 1976. (In addition to Agency activities, the American National Standards Institute is in the process of revising ANSI C107.1–1974, its guidelines for disposal of askarels containing PCBs.) As significant new information becomes available from these and other sources, this FEDERAL REGISTER issuance will be revised.

The purpose of this issuance is to provide guidance for the disposal of PCB-containing wastes. This guidance is addressed primarily to *industrial users* of PCBs, particularly those manufacturing and/or using capacitors and transformers containing PCBs, although the recommended procedures are appropriate to all PCB-containing wastes.

General Background. — Polychlorinated biphenyls (PCBs) are chlorinated aromatic organic compounds which give rise to concern because of their chronic toxicity, their pervasiveness and persistence in the environment, and their tendency to accumulate in food chains (including man), resulting from the bioaccumulation of PCBs in the food chain, cause the present and continuing concern over the disposition of PCBs to the environment. PCBs have been used both in closed systems, especially as sealed dielectric fluids in transformers and capacitors, and consumptive (or "open") applications, where the PCBs are used in and consumed and discarded with a product.

In the past, consumptive or "open" uses of PCBs have included: impregnators of cotton and asbestos for braided insulation of electrical wiring; plasticizers in wire and cable coatings; plasticizers of vinyl chloride polymer films; components of high-pressure hydraulic fluids; specialized lubricants and gasket sealers; heat transfer agents; and machine tool cutting oils. Former "open" applications also include: formulation into some epoxy paints; protective coatings for wood, metal, and concrete; adhesives; and in carbonless reproducing paper.

Today domestically produced PCBs are supplied only to "closed" applications in the electrical power distribution industry. PCBs used as dielectric fluids in transformers and capacitors are referred to generally as askarels.

Capacitor applications include power factor correction of both high and low voltage power, ballasting in fluorescent lamps, and motors in air conditioners and industrial applications. Transformer use of PCBs is primarily in those areas where the non-flammability is the major consideration (largely those applications in proximity to humans). These include transportation applications (electric trains, rapid transit systems) and power supply transformers in commercial and public buildings.

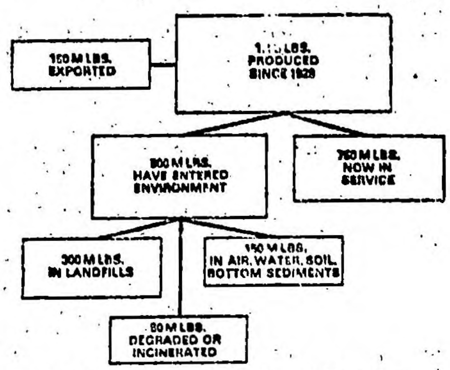
The sole producer of PCBs in the United States is the Monsanto Company, under the trade name of Aroclor. Some domestic manufacturers either modify Aroclor or have Monsanto prepare special formulations for them. These have been marketed and used by manufacturers in their products under various trade names. Additional quantities of PCBs are imported, both as a raw material and as a substance incorporated into manufactured parts or products. Appendix A provides a listing of the trade names used by domestic and foreign manufacturers on their products containing PCBs.

Cumulative sales in the U.S. since the introduction of PCBs in 1929 are estimated to be 1.5 billion pounds. An estimated 750 million pounds of the PCBs produced are still in service. It is estimated that less than half the PCBs ever produced have entered the environment; of this amount, only about 10 percent (50 million pounds) are estimated to have degraded or been incinerated; 300 million pounds are estimated to be in landfills at this time. This distribution of PCBs is illustrated on Figure I. The recommendations of this publication are directed only at the PCBs presently in service (or which will enter service as a result of future production).

In 1970 Monsanto voluntarily restricted domestic sales of PCBs to use in transformers and capacitors (closed systems). As a result, current domestic production of PCBs is down about 50 percent from the peak years before 1970, but still amounts to about 40 million pounds per year (1974). Imports of PCB liquids currently amount to about 0.4 million pounds per year.

FIGURE 1

PCB HISTORY IN THE U.S.



Most capacitors (using PCBs) produced in the past two years use Aroclor 1016, while transformer applications continue to use Aroclor 1242 and 1254.

Technical Background.—Polychlorinated biphenyls are a class of synthetic compounds which have no known counterpart in the natural environment. PCBs are manufactured by the chlorination of biphenyl with anhydrous chlorine using iron filings or ferric chloride as a catalyst. The most important physical properties of PCBs are low vapor pressures, low water solubility, and high dielectric constants. They are miscible with most organic solvents.

The chemical properties that make PCBs desirable industrial materials are their excellent thermal stability, their strong resistance to both acidic and basic hydrolysis, and their general inertness. They are quite resistant to oxidation. Unfortunately, some of the characteristics (stability, nondegradability) which make PCBs so valuable in industrial applications also make them highly persistent in the environment.

Theoretically 210 PCB compounds can be prepared, but less than 100 homologs and isomers are likely to occur in commerical products. PCB compounds contain from 12 to 68 percent chlorine. The typical commercial product is a mixture of several homologs.

Monsanto, the sole U.S. producer of PCBs, has adopted a four-digit designation for its Aroclors. The first two digits indicate the type of material: biphenyl, triphenyl, or mixture of the two. The last two digits represent the approximate chlorine content by percentage weight. (Aroclor 1016, with approximately 41 percent chlorine, is an exception to this nomenclature system.) Biphenyls with higher chlorine content are non-flammable and have extremely low volatilities.

The chemical stability, low volatility, high dielectric constant, and compatibility with other chlorinated hydrocarbons have resulted in many and varied industrial applications for the PCBs.

The ready solubility of PCBs in nonpolar solvents explains why they are easily absorbed into fatty tissue and into the liver. Fatty tissue acts as a nonpolar solvent, and PCBs are retained, rather than excreted. Their resistance to

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oxidation or other types of chemical degradation explains their persistence and accumulation in animal tissue.

The chemical inertness and resistance to metabolism of PCBs account for their low acute toxicity. Chronic toxic effects vary in different animal species; they include skin, liver, and kidney lesions in rabbits as well as chloracne and hepatotoxic effects in man.

The low solubility of PCBs in water probably limits the rate at which they are dispersed by water systems. PCBs discharged into a river or lake will accumulate in the sediment in relatively high concentrations. Plants and animals can concentrate PCBs above their level in water alone. Some fish species taken from Lake Michigan in 1970 and 1971 have exhibited PCB concentrations greater than 5 ppm. Shrimp and oysters exposed to 10 ppb of Aroclor 1254 have shown bioaccumulations from 130- to 3300-fold; bioaccumulations in some species of 40,000 to 75,000 have been experienced.

PCBs are not intended to get into the environment, but they do because their unique chemical properties prevent them from being destroyed by usual waste treatment methods. Thus, they inadvertently escape and become widely dispersed. Environmental transport models for PCBs have not been developed. Conclusions regarding their behavior, particularly their distribution and transport in the environment, are based largely upon the results of DDT research. Recent data indicates that aerial transport may play a major role in the worldwide dissemination of PCBs, although dumping and river runoff may contribute more importantly to local contamination of fish, wildlife, and drinking water sources. Degradation characteristics of PCBs are not well understood. Some dibenzofurans, which are extremely toxic, may be degradation products of PCBs.

Disposal of PCB-Containing Wastes.—The persistence of PCBs necessitates extremely careful attention to final disposition of PCBs and PCB-containing materials. First, the use of PCBs should be reduced. Manufacturers or users should use more environmentally acceptable substitute materials whenever possible. However, spills, damaged goods, and housekeeping materials will require disposal. All absorbents and other cleanup materials should be carefully selected with disposal implications in mind.

Reclamation of PCBs is usually feasible only with relatively uncontaminated liquids and should be carried out only if there is virtually no chance of PCB losses to the environment. Recycling is advisable only as long a adequate substitutes for PCBs are not available. Monsanto maintains a toll-free telephone number (800/325-3850) for the public for advice on scrap PCBs. If liquids cannot be reused, these liquids should be disposed of by high temperature incineration.

Recycling of transformer fluids is accomplished by several companies. The tank and inside copper of the transformer is reclaimed; the PCB liquids, if they cannot be reused, should be incinerated.

PCBs can be leached from solid manufacturing wastes with a suitable solvent, e.g., trichloroethylene or acetone. The decontaminated waste can then be disposed. The solution containing PCBs may be separated by distillation into PCB, which may be reclaimed, and the solvent, which may be used again. The distillation technique is also applicable to remove PCBs from contaminated liquids. This technique (of leaching and reclamation) is especially useful after accidental spills of liquid PCBs. Spills could be absorbed on dry sand, ash, sawdust, or commercial absorbents and then processed as above.

As noted on Figure I, there are approximately 750 million pounds of PCBs, incorporated into products, currently in service. These products will utilmately require disposal. If a capacitor or transformer has a label identifying one of the trade names shown in Appendix A, it should be handled as a PCB, and the options listed below followed. If the contents are unknown, but the manufacturer is one of those listed in Appendix A, an inquiry should elicit information on the contents of the equipment or product

Effective safeguards should be employed in the handling and transport of the PCB-containing wastes. These include the use of protective clothing, closed containers for transportation, and adequate labeling to alert personnel to hazards from routine disposal as well as emergency response in the event of a spill or accident.

Anyone responsible for the disposal of PCBs should select high-quality firms for the transport and disposal of their PCB-containing wastes. Also, spot-check to assure transported, and disposed is recommended. The generator of the waste should take responsibility for proper waste management.

Recommended options for the disposal of PCB-containing wastes (in priority order) are:

Incineration
Controlled land disposal

Incineration—The proper incineration of waste PCB must involve a suitable balance among temperature in the incinerator, dwell time in the firing chamber, and oxygen availability. Also, a suitable scrubber should be provided on the exhaust stack to remove the hydrochloric acid mist that is formed. Exhaust gases should be monitored to assure compliance with air regulations.

Recommended requirements are: (1) 2-second dwell time at 1100 C (2000 F) and 3 percent excess oxygen in the stack; or (1) 1½ second dwell time at 1500 C (2700 F) and 2 percent excess oxygen in the stack gas.[1] Open hearth and other incinerators used for municipal refuse incineration are not normally suitable; the relatively low operating temperature of such equipment would only volatilize the PCBs and pollute the atmosphere. In addition, instrumentation and handling equipment are usually not sufficient for managing hazardous materials. Therefore, PCB-containing waste should not be sent to such municipal incinerators for disposal.

The above recommendations are suitable for liquids. Incineration of solid wastes containing PCBs has not been demonstrated. However, such destruction does appear feasible. For example, a rotary kiln furnace, with an afterburner and scrubbing system, could probably safely incinerate solid wastes containing PCBs. Likewise, other smaller, high temperature incinerators with sufficient residence times may be satisfactory for the smaller waste generator.

As a service, Monsanto will incinerate (for a fee) any returned liquids in their high temperature incinerator. A technical description of the Monsanto incinerator is provided in Appendix B.

EPA publication, *Hazardous Waste Management Facilities* (EPA/530/SW-146),[2] provides information on some incineration facilities. Use of these facilities for incineration of PCB-containing waste should be checked with EPA Regional and State representatives to assure that the facilities have adequate environmental controls to meet Federal/State/local regulations.

Land Disposal—Wastes containing PCBs should not be disposed of with other mixed wastes in a sanitary landfill (See EPA Guidelines on Thermal Processing and Land Disposal of Solid Waste, Federal Register, August 14, 1974). Characteristics of transport of PCBs through the soil are not definitively established. The interaction with other decomposing wastes is not well understood. Some landfills may contain or accept wastes which could cause the release of PCBs. The ubiquity and persistence of PCBs indicate that their disposal should be carefully controlled until additional data are developed. While these data are being gathered, PCBs (when disposed to the land) should only be placed in a secure chemical waste landfill.

In general terms, a chemical waste landfill provides complete long-term protection for the quality of surface and subsurface waters from hazardous waste deposited therein, and against hazards to public health and the environment. Such sites should be located or engineered to avoid direct hydraulic continuity with surface and subsurface waters. Generated leachates should be contained, and subsurface flow into the disposal area eliminated. Monitoring wells should be established, and a sampling and analysis program conducted. Additional characteristics of a chemical waste landfill are described in EPA publication, *Landfill Disposal of Hazardous Wastes: A Review of Literature and Known Approuches* (EPA/530/SW-165).[2]

[1] These values are from ANSI C107.1-1974. Guidelines for Handling and Disposal at Capacitor and Transformer-Grade Askarels Containing Polychlorinated Biphenyls, American National Standards Institute.

[2] Documents referenced here may be obtained from Solid Waste Information, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

Encapsulation of wastes in cement prior to bureau in a sanitary landfill has been used for small quantities of solids or sludges. This is usually done by casting the waste in concrete inside a drum prior to deposition in the landfill.

Only those specific sites which have been State-approved for PCB wastes should be used. The EPA publication, *Hazardous Waste Management Facilities*, (EPA/530/SW-146 provides some information to potential disposers; these data when used in consultation with State solid waste management officials can assist in a disposal action.

Dated: March 26, 1976.

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Assistant Administrator for Air and Waste Management.

APPENDIX A

LISTING OF NAMES USED FOR PCBS BY MANUFACTURERS

Name:	*Manufacturer*
Aroclor	Monsanto.
Asbestol	American Corp.
Askarel	[1]
Chlorextol	Allis Chalmers.
Diaclor	Sangamo Electric.
Dykanol	Cornell Dubilier.
Elemex	McGraw Edison.
Hyvol	Aerovox.
Inerteen	Westinghouse Electric.
No-Flamol	Wagner Electric.
Pyranol	General Electric.
Saf-T-Kuhl	Kuhlman Electric.
Clophen	Bayer (Germany).
DK	Caffaro (Italy).
Fenclor	Caffaro (Haly).
Kennechlor	Mitsubishi (Japan).
Phenoclor	Prodelec (France).
Pyralene	Prodelec (France).
Santotherm	Mitsubishi (Japan).

[1] Generic name used for insulating liquids in capacitors and transformers; may contain PCBs.

APPENDIX B—DESCRIPTION OF MONSANTO INCINERATION FACILITY

SAUGET, ILLINOIS

Background.—The Krummrich Plant is one of Monsanto's large chemical manufacturing plants. The product line includes sulfuric acid, benzene, chlorine, polychlorinated biphenyls, several rubber compounds, and various chemical intermediates. The plant is located immediately south of East St. Louis, Ill. near the Mississippi River. Since June 1971, Monstanto has operated a liquid injection incinerator to dispose of in-house liquid wastes and contaminated PCBs from customers.

Waste Characteristics.—The large majority of the wastes burned are PCB derivatives. The sources of these wastes are process still bottoms and contaminated transformer oils. The heating value of the materials is about 9000 BTU/lb. Other in-house high BTU liquid wastes are also incinerated. Phosphorous compounds cannot be burned due to the formation of particulates (P_2O_5) which foul the injection system. The system is not equipped to handle suspended solids. Four 20,000 gallon tanks are available for storage. The wastes are typically stored for several days before incineration to allow undissolved solids to settle. After the settling period, the wastes are pumped directly from the tanks to the liquid combustor.

Incinerator Description.—The incinerator is a liquid injection type housed in a horizontal cylinder 20 ft. long and 9.5 ft. in diameter. High pressure steam is used to atomize the waste liquid and inject it into the liquid combustor. The feed rate measures 2 gal/min. An additional gun which burns natural gas is also positioned inside the plenum. The natural gas serves as an auxiliary fuel to supplement the heating value of the waste if necessary. The operating temperature varies from 2000° to 2200° F. If the temperature is too high, water can be sprayed into the chamber to act as a heat sink. The cylinder is protected from the heat by a lining of refractory brick. High alumina brick is used in the plenum chamber. A blower supplies 25% excess air forcing the fumes from the plenum and through an oxidizer. The residence time inside the oxidizer is 2-3 seconds.

The unit is operated 24 hours/day requiring 2 men/shift. Initial capital costs were $740,000. The disposal cost has averaged 10¢/lb.

Air Pollution Control.—The fumes exit the oxidizer and enter a water quench column. The main purpose of the quench is to reduce the temperature of the hot fumes. Particulates are removed next in a high energy venturi scrubber. Finally, the emissions are cleaned in a packed bed (polypropylene packing) at the base of the stack. The 40 ft. stack is equipped with a demister.

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