JAN 30 1976

Recommended Procedures for the Disposal of PCB-Containing Wastes (Industrial Facilities)

DRAFT

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. The Agency is also evaluating the consumer waste disposal problem and may issue further guidance on that subject at a later time.

General Background

Polychlorinated biphenyls (PCBs) are chlorinated aromatic organic compounds which give rise to concern because of their toxicity coupled with their pervasiveness and persistence in the environment and their tendency to accumulate in food chains. It is this bioaccumulative characteristic which manifests itself by possible adverse effects on animals, including man, that causes the present and continuing concern over the disposition of PCBs to the environment. PCBs have been used both in closed systems, defined as applications where the PCBs are recoverable, and consumptive applications, where the PCBs are used in and consumed with the product.

Uses of PCBs include formulation into ballasts for fluorescent fixtures; impregnation of cotton and asbestos for

braided insulation of electrical wiring; a plasticizer in wire and cable coatings; capacitors and askarel-type transformers; and plasticizers of vinyl chloride polymer films. PCBs used as dielectric fluids in transformers and capacitors are referred to generically as askarels. Because of their thermal stability and fire resistance, PCBs also find application in high-pressure hydraulic fluids, specialized lubricants and gasket sealers, heat transfer agents, and machine tool cutting oils. Miscellaneous uses include: formulation into some epoxy paints; protective coatings for wood, metal, and concrete; adhesives; and in carbonless reproducing paper.

The sole producer of PCBs in the United States is the Monsanto Company, under the trade name of Aroclor. PCBs have also been marketed and used by manufacturers in their products under various trade names. Appendix A provides a listing of the trade names used by domestic and foreign manufacturers. Cumulative sales in the U.S. since the introduction of PCBs are estimated to be 1.5 billion pounds. In 1970 Monsanto voluntarily restricted domestic sales to transformers and capacitors. As a result, current production is down about 50% from the peak years before 1970, but still amounts to about 40 million pounds per year. Monsanto has introduced Aroclor 1016 which is reported to have lower toxicity and higher biodegration rates. Most capacitors

(using PCBs) produced in the past two years use Aroclor 1016.

Almost all of the PCBs ever produced still present a serious threat to the environment because of their toxicity, bioaccumulative characteristic in the food chain and slow degradation. An estimated 750 million pounds of PCBs produced are still in use; 300 million pounds are estimated to be present in landfills. It is estimated that less than half the PCBs ever produced have entered the environment; of this amount, only about 10% (50 million pounds) are estimated to have degraded or been incinerated. The recommendations of this document are directed only at the PCBs presently in service (or which will enter service as a result of future production).

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-contaminated waste materials. In addition, 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 1976. The Agency is also aware that the American National Standards Institute is in the process of revising its guideline for disposal of askarels containing PCBs

(ANSI C107.1-1974). 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.

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 three 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.

In the process of replacing hydrogen atoms with chlorine atoms, a large number of substitution combinations arise.

Theoretically 210 PCB compounds can be prepared, but the number of isomers observed in commercial formulations is significantly smaller. In commercial preparation, PCB compounds contain from 12 to 68 percent chlorine; the typical product is a mixture of several PCBs.

Monsanto, the sole U.S. producer of PCBs, has adopted a four-digit designation for its Aroclors; the last two digits represent the approximate chlorine content by percentage weight. The first two digits indicate the type of material: biphenyl, triphenyl, or mixture of the two. The higher chlorinated biphenyls are non-flammable and have extremely low volatilities. Unfortunately, some of the characteristics (stability, non-degradability) which make PCBs so valuable in industrial applications also make them highly persistent in the environment.

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 solubility of PCBs in nonpolar solvents explains why they are readily absorbed into fatty tissue and into the liver. Their resistance to oxidation or other types of chemical degradation explains their persistence and accumulation in animal tissue. The latter effect is enhanced both by their insolubility in water and solubility in organic solvents. Their chemical inertness and resistance to metabolism account for their low acute toxicity. But as they

slowly build up in a living system, their concentration approaches toxicity levels, at which point chronic effects make themselves evident.

The low solubility of PCBs in water probably limits the rate at which they are dispersed by water systems, but does not seem to limit their range of dispersion. PCBs discharged into a river or lake will accumulate in the sediment in relatively high concentration. Plants and animals can concentrate PCBs above their level in water alone. Shrimp and oysters exposed to 10 ppb of Aroclor 1254 have been known to bioaccumulate from 130- to 3300- fold.

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 disposal 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 is the most efficient route, although dumping and river runoff will contribute more effectively to local contamination.

Disposition of PCBs

The persistence of PCBs necessitates extremely careful attention to final disposition of PCBs and PCB-contaminated

materials. Initial attention within the manufacturing or PCB-user facility should be given to reducing the use of PCBs. Manufacturers or users may either use substitute (less contaminating) materials or more efficient methods which produce less waste. However, no matter how many substitutes are developed and no matter how efficient the operation may become, there may still remain some applications for which PCBs are the current optimum material and there still will be waste materials. Spills, damaged goods, and housekeeping materials will require disposal. Recommended options for the disposal of PCB-containing wastes (in priority order) are:

- Reclamation or recycling
- Incineration
- Controlled land disposal

Recycling - Reclamation or recycling of PCBs is usually feasible only with relatively uncontaminated liquids. Monsanto maintains a toll-free telephone number (800/325-3850) for the public for advice on scrap PCBs. If liquids cannot be reused, Monsanto will incinerate returned liquids in their high temperature incinerator. A technical description of the Monsanto incinerator is provided in Appendix B.

Recycling of transformers is accomplished by General Electric Co. and several independent companies. The tank and inside copper of the transformer is reclaimed; the PCB liquids,

if they can't be reused, can be drained and incinerated at facilities such as General Electric's Pittsfield, Massachusetts, plant.

It is quite possible to leach out the PCBs from solid wastes with a suitable solvent, e.g., acetone, and then dispose of the decontaminated waste. The solution containing PCBs may be separated by distillation into PCB, which may be reclaimed, and the solvent which may be used again. This technique (of leaching and reclamation) is especially useful after accidental spills of liquid PCBs. The spills should be absorbed on dry sand, ash, sawdust, or commercial absorbents and then processed as above.

Incineration - Present knowledge indicates that the proper incineration of waste PCBs must involve a suitable balance among temperature in the incinerator, dwell time in the firing chamber, plus oxygen availability. Also, a suitable scrubber must be provided on the exhaust stack to remove the hydrochloric acid mist that is formed.

Preferred requirements are: (1) 2-second dwell time at 1100°C(2000°F) and 3% excess oxygen in the stack; or (2) 1 1/2 second dwell time at 1500°C(2700°F) and 2% excess oxygen in the stack gas.* These alternates are recommended. Open hearth incinerators are not considered suitable; the relatively

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

low operating temperature of this equipment would only volatilize the PCB and pollute the atmosphere.

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.

Land Disposal - Wastes containing PCBs should not be disposed of with other mixed wastes in a sanitary landfill. Characteristics of transport of PCBs through the soil are not definitively established. The interaction with other decomposing wastes is not well understood. 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

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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 Approaches (EPA/530/SW-165)**. Encapsulation of wastes in cement prior to burial in a sanitary landfill has been used for small quantities of solids or sludges contaminated with PCBs. 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; this data when used in consultation with State solid waste management officials can assist in planning a disposal action.

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

Appendix A

Listing of Names Used for PCBs by Manufacturers

Name	Manufacturer
Aroclor	Monsanto
Asbestol	American Corporation
Askarel	*
Chlorextol	Allis Chalmers
Diaclor	Sangamo Electric
Dykanol	Cornell Dubilier
Elemex	McGraw Edison
Hyvol	Aerovox
Inerteen	Westinghouse Electric
No-Flamol	Wagner Electric
Pyronol	General Electric
Saf-T-Kuhl	Kuhlman Electric
Clophen	Bayer (Germany)
Fenclor	Caffaro (Haly)
Kennechlor	Kenneclor (Japan)
Phenoclor	Prodelic (France)
PK	Caffaro (Italy)
Pyrolene	Prodelec (France)
Santotherm	Mitsubishi (Japan)

* generic name used for insulating liquids in capacitors and transfomers; 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, Monsanto 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, spoiled batches, 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 increase 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 aluminum 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 capitol 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. 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. Scrubber liquors are drained to the sewer without treatment.

REFERENCES

1. Polychlorinated biphenyls and the environment, Inter-departmental Task Force on PCB's. Depts. of Agriculture, Interior, HEW, Commerce and EPA, May 1972.

2. Carnes, R., Doerger, J., Spearks, H.L. Polychlorinated biphenyls in solid waste and solid-waste-related materials. Cincinnati. 1973.

3. American National Standards Institute (ANSI). Guidelines for handling and disposal of capacitor-and transformer-grade askarels containing polychlorinated biphenyls. New York, January 1974.

4. Peaksall, D.B. PCB's and their environmental effects. Critical Reviews in Environmental Control. CRC. 1975.

5. Broadhurst, M. Use and replaceability of polychlorinated biphenyls. Environmental Health Perspectives. Oct. 1972.

6. Versar, Inc. Assessment of wastewater management, treatment technology, and associated costs for abatement of PCBs concentrations in industrial effluents. Jan. 1976. (Draft report).

7. Bremer, C. State of concerns of the Lake Michigan Toxic Substances Committee related to PCB. Chicago. Internal EPA Report.

8. Aroclor.Polychlorinated polyphenyls (biphenyls). Technical Bulletin O-FF/IR. St. Louis: Monsanto Industrial Chemicals Company, Nov. 1971.

9. PCB's-environmental impact. Environmental Research. 1972.

10. PCB's their use and control. Organization for Economic Cooperation and Development. Paris. 1974.

11. Sewage sludge incineration. Section IV. Effect of incineration on metals, pesticides, and polychlorinated biphenyls. EPA Task Force. March 1972.

12. PCB Conference. National Swedish Environment Protection Board. 1970. pg. 83-86.

13. Hazardous waste management facilities in the United States. Leshendok, T. Environmental Protection Agency SW-146, revised, 1976.

14. Scurlock, A. et al. Incineration in hazardous waste management. Environmental Protection Publication SW-141, 1974.

15. Lindsey, F. and Fields, T. Landfill disposal of hazardous wastes: review of literature and known approaches. Environmental Protection Publication SW-165, 1975.

16. Farb, D. information about hazardous waste management facilities. Environmental Protection Publication SW-145, 1975.

17. Tucker, E., et al. Migration of PCB's in soil induced by percolating water. Monsanto Co. Bulletin of Environmental Contamination and Toxicology, Vol. 13. 1975

18. ASTM. Standard method of test for rapid gas chromatographic estimation of higher boiling homologues of chlorinated biphenyls for capacitor askarels. specification D 1810-63 (1973).

19. HEW. Registry of toxic effects of chemical substances. 1975 Edition NIOSH June 1975.

20. Mitre Corp. Environmental cycling of PCB's. 1975 (unpublished report).