

## PCB WHITE PAPER



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## EXECUTIVE SUMMARY

Widespread interest in the environmental significance of PCBs has led to intensive research into the hazards and distribution of these pollutants. Review of the conclusions from these investigations led to the promulgation of regulations controlling the manufacture, distribution, use, and disposal of PCBs. This document has been prepared in an effort to briefly summarize pertinent federal regulatory actions and the technical justifications and economic analysis performed prior to the promulgation of the regulations.

## INTRODUCTION

The PCB materials are polychlorinated biphenyls and terphenyls containing a mixture of compounds and isomers in which the chlorine content can range from 18 to 79 percent by weight. The mean percentage for chlorine content is controlled to give the required chemical and physical properties as determined by the application to be met.

The world's largest producer, and the sole producer in the U.S., has been the Monsanto Company. Commercial production began in 1930 and cumulative world production since then is generally estimated to be on the order of 1 to 1.2 million tons.

It is a combination of highly desirable properties that has led to widespread use of PCBs. They are liquid over a wide temperature range, have low vapor pressure (high boiling temperatures), are excellent dielectric materials, and exhibit very high thermal and chemical stability. They have found use in a variety of applications including dielectric fluids, carbonless carbon paper, heat transfer fluids, hydraulic fluids, and cutting oils.

Cases of PCB poisoning were reported first in the manufacturing industry during the 1930's. This occupational disease was characterized by aneiform and occasional impairment of the liver. Beginning in 1953 cases were reported in Japanese industries manufacturing condensers. The acute toxic effects of PCBs were brought to the forefront of the public's attention in 1968 after PCB-contaminated cooking oil caused widespread poisoning in Japan. Other incidents of PCB food contamination in the U.S. have brought increased attention to PCB uses and the related dissemination into the environment. Since 1966 many studies have shown distribution in the environment to be extensive.

An estimated 500 thousand tons of PCBs have entered dumps and landfills where they in all likelihood are chemically stable but subject to slow release. A list follows for the major routes by which PCBs enter the environment:

- By leaching, dust transport, burning of wastes, seepage, and erosion from landfills holding PCB wastes and PCB-containing wastes.
- From dumpsites of convenience (back lots, woods, roadsides, swamps, idle land, etc.) by the same mechanisms as from officially designated landfills.
- Direct discharge of PCB wastes and waste-containing products into streams, rivers, and other waterways.
- Recycling of PCB-containing paper.
- Discharge into sewage system.

- Runoffs of insecticides in which PCBs were used to extend the kill-life.
- Industrial smoke from inadvertent incineration of PCB-containing materials.

As industry and government became increasingly aware of the hazards and environmental degradation associated with the use of PCBs, their sale was restricted and regulations appeared to control their manufacturing and disposal.

As documented by the World Health Organization, "the serious outbreaks of poisoning in man and domestic animals from the ingestion of food accidentally contaminated with PCBs have stimulated investigations into the toxic effects of PCBs in animals and on nutritional food chains." As a result in 1973 the U.S. Food and Drug Administration (FDA) established temporary limitations of PCBs in food. Need for this action was further confirmed by an FDA surveillance and inspection program which identified numerous lots of contaminated foods.

#### REGULATION OF PCBs

From July 1969 to August 1971, nine incidents of PCB contamination of food were reported. No record of human PCB poisoning in the U.S. has occurred, but near disasters have resulted in regulatory action. In 1973, the FDA established temporary limitations of PCBs in food. A surveillance and inspection program by the FDA detected numerous lots of contaminated foods.

The Clean Water Act of 1977 contains the first regulation by the Environmental Protection Agency (EPA) regarding PCBs. Under Section 307(a), manufacturers of electrical transformers and capacitors were prohibited from discharging PCBs into waterways (Federal Register, Vol. 42, February 2, 1977, pp. 6532-6556). These regulations stipulated February 2, 1978, as the deadline for compliance, allowing affected manufacturers 1 year to take the necessary steps (e.g., use of substitute materials and equipment or process changes) to eliminate PCBs from their effluents.

On March 26, 1976, as work was being performed on promulgation of regulations for toxic effluents under the Clean Water Act, Senator Gaylord Nelson of Wisconsin introduced an amendment to the Toxic Substances Control Act (TSCA) for the phasing out of PCBs in manufacturing processes in the U.S. The TSCA was promulgated on October 11, 1976, and contained this amendment as Section 6(e). Section 6(e) requires the EPA to control the manufacture, processing, distribution, use, and disposal and marking of PCBs.

The disposal and marking rule for PCBs, Section 6(e)(1), was promulgated by the EPA on February 17, 1978 (Federal Register, Vol. 43, No. 34, pp.

7150-7164), and clarified in an addendum of August 2, 1978 (Federal Register, Vol. 43, No. 149, pp. 33918-33920). EPA published the proposed rules for Sections 6(e)(2) and 6(e)(3), which regulated PCB use, on June 7, 1978 (Federal Register, Vol. 43, pp. 24802-24817). These rules were supported by documentation, voluntary environmental impact statements and numerous public hearings. On November 1, 1978, EPA published interim rules for Section 6(e)(3)(B) establishing procedures for persons to petition the Administrator of EPA for exemptions from prohibitions to manufacture, process, or distribute in commerce PCBs. The final rule, promulgated on May 31, 1979 (Federal Register, Vol. 44, No. 106, pp. 31514-31568) declares the prohibition of processing, manufacturing, and distributing of PCBs after July 1, 1979, unless specifically exempted by EPA. The final rule became effective July 2, 1979.

#### TECHNICAL JUSTIFICATION FOR THE FINAL RULE

##### Destruction in High Efficiency Oil-Fired Boilers

Prior to the finalization of the PCB rule, both theoretical calculations and field data were available which offered convincing evidence of the ability of an oil-fired boiler to destroy various concentrations of PCBs.

In October of 1976, Monsanto Research Corporation published a theoretical study on PCB emissions from stationary sources.<sup>1</sup> This report not only addressed the potential of formation of PCBs during the combustion of fossil fuels, but also the destruction of PCBs. The conclusion reached was that under thermodynamically controlled situations the "chlorinated biphenyls would react to essentially extinction."<sup>1</sup>

Prior to the publication of the Monsanto study, in May 1976, Florida Power and Light Company had reported on the results of a PCB burn conducted at their Sanford Unit No. 4. The stack sampling and analysis for PCBs was conducted by a private contractor. The results of this test in which PCB-contaminated oil was fired along with No. 6 fuel oil revealed no detectable amount of PCBs in the stack gas. The Method 5 particulate train was used for sampling, and Aroclor pattern matching by gas chromatograph-electron capture detection (GC-ECD) was used for analysis.<sup>2</sup>

In October of 1976 the EPA published a report detailing the emission testing at the Continental Can Company in Hopewell, Virginia, during PCB burning. This investigation reached the conclusion that the power boilers tested achieved greater than 99 percent destruction efficiency of the PCB present in the fuel.<sup>3</sup>

In December of 1977 the University of Dayton Research Institute under contract to the EPA published a report on the laboratory evaluation of high-temperature destruction of PCBs and related compounds. This evaluation established that PCBs could be destroyed at greater than 99.995 percent molecular destruction at a residence time of 1 second and a temperature of 1000°C.<sup>4</sup>

## Destruction in Incineration Systems

Prior to the finalization of the PCB rule, incineration tests of high concentrations of PCBs had been conducted. In December 1976 the rotary kiln installation at Rollins Environmental Services, Inc., was tested for its ability to destroy PCBs.<sup>5</sup> The PCBs were introduced to the rotary kiln in the form of contaminated whole capacitors and contaminated hammermilled capacitors. Calculated PCB destruction efficiencies for whole capacitors were 99.5 percent and for hammermilled capacitors, greater than 99.999 percent. The gas residence time in this system is on the order of 2 to 3 seconds with a flame temperature of about 1500°C.

In January 1976 PCB destruction tests were conducted at the St. Lawrence Cement Co.<sup>6</sup> The destruction efficiency of PCBs was calculated to be 99.986 percent. The kiln was maintained at 1450°C with an approximate residence time of 3 seconds.

In another test in 1976 at the Continental Can Company, PCBs in waste oil were fired into a rotary lime kiln maintained at 1260°C during the tests.<sup>3</sup> Destruction efficiency at this site was found to be 95.4 percent.

In a test in Sweden conducted by the Swedish Water and Air Pollution Research Institute a rotary cement kiln achieved a 99.9998 percent destruction efficiency of PCBs.<sup>7</sup>

These data for both high efficiency boilers and rotary-type kiln incinerators provided a convincing argument for the ability of these units to achieve high destruction efficiency of PCBs.

## ECONOMIC ANALYSES FOR THE FINAL RULE

Prior to the promulgation of the final rule, economic analyses were conducted to assess the impact of the proposed rule. Versar, Inc., of Springfield, Virginia, prepared two documents for EPA: Microeconomic Impacts of the Proposed Marking and Disposal Regulations for PCBs (April 1977) and Microeconomic Impacts of the Proposed "PCB Ban Regulations" (May 1978). Versar revised these documents upon the request of EPA prior to the promulgation of the final rule. The final report is entitled PCB Manufacturing Processing, Distribution in Commerce, and Use Ban Regulation: Economic Impact Analysis, March 30, 1979.

Versar concluded that the proposed marking and disposal regulation would cost an estimated \$62.2 million the first year. The cost would include new incinerators, new storage facilities, operating costs, chemical waste land-fill charges, disposal transportation costs, recordkeeping for marking, and maintenance of storage facilities. The major economic impacts would apply to: utilities owning and using large high voltage capacitors; owners and users of high intensity discharge lighting capacitors, small capacitors, large low voltage capacitors, or equipment containing such capacitors; manufacturers of equipment containing PCB articles; and manufacturers of large low voltage capacitors, small capacitors and fluorescent light ballasts.

The analysis of economic impacts for the PCB ban regulation was divided into transitional and long-term cost impacts. The transitional costs are those costs necessary to eliminate all existing PCB-containing equipment from service. For example, the total cost of the ban on sales of PCB capacitors and equipment after July 1, 1979, including inspection and rework costs, could easily exceed \$1 billion. The long-term costs will be continuing costs and will have a long-term economic impact. Examples include the increased cost of non-PCB transformers and power factor capacitors.

#### SAMPLING AND ANALYSIS

As a support document to the final rule PCB regulations of May 31, 1979, EPA published an interim sampling and analysis manual for PCB Disposal.<sup>8</sup> This manual provides guidance on several key aspects of PCB monitoring. These include the following.

- Spill contamination levels - Surface and subsurface samples of the entire suspected contamination area must be taken and analyzed for PCB content using the air dried, 10 percent moisture added SOXHLET extraction procedure.
- Monitoring feed rate - For liquids, any conventional commercially available flow meter is acceptable. Instruments which provide real-time measurement in a visual display are recommended. For solid PCB materials, load weights should be determined by weighing several representative loads and averaging them.
- Monitoring incineration operations and combustion products - Combustion temperature must be monitored to insure: a 1.5 second dwell time at 1600°C and 3 percent excess oxygen. Specifications for instrumentation to monitor flue gas temperature (thermocouples), carbon monoxide and carbon dioxide (nondispersive infrared (NDIR) analyzers) and excess oxygen (paramagnetic or electrochemical devices) are given. Flue gas temperature and scrubber water monitoring locations are recommended and a method for calculating dwell time is presented.
- Conducting and monitoring a test burn - Pretest equipment checks and safety procedures are established. The following non-continuous stack monitoring procedures for combustion products are specified.



CO, CO <sub>2</sub> , O <sub>2</sub> --	EPA Method 3
Total particulate --	EPA Method 5
NO <sub>x</sub> --	EPA Method 7
HCl --	Collected with an impinger filled with caustic. Analyzed for chloride ion using the Mercuric Nitrate Method (as described in <u>Standard Methods for the Examination of Water and Wastewater</u> ).
Total chlorinated organic content and PCB --	Collected on a solid sorbent trap such as XAD-2 amberlite resin, which is located in the sampling train downstream of the heated filter and upstream of the first impinger. The sample is then removed from the trap via a 24-hour SOXHLET extraction with both pentanol and methanol. Extracts are dried with sodium sulfate and concentrated to 10 ml. Finally the sample is analyzed for PCB and RCL content by Gas Chromatography - Mass Spectroscopy.

The manual includes as attachments, details of analysis methods cited and should be referenced for specific sampling and analysis questions.

## CONCLUSION

The intent of environmental legislative action is to protect the public health and welfare. This is accomplished by setting standards; establishing agencies capable of enforcing these standards; and actually implementing technical and administrative mechanisms for the effective enforcement of pollution controls. Another function of statutory law is to establish conservation and development programs to enhance the quality of the environment. The promulgation of these regulations pursuant to Section 6(e) of TSCA exemplifies this intent.

The regulations as finally implemented serve as an excellent guide to the future use, storage and disposal of PCBs. However, the potential for exposure will remain until all PCBs have been adequately contained or destroyed as specified in the regulations.

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