

POLYCHLORINATED BIPHENYLS 1929-1979 :

FINAL REPORT

Final Report

Submitted to:

U.S. Environmental Protection Agency
Office of Toxic Substances
Washington, D.C. 20460

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Contract No. 68-01-3259

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May 16, 1979



NEV 023363

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PREFACE

This report summarizes the work on Polychlorinated Biphenyls (PCBs) that Versar performed for the U.S. Environmental Protection Agency under Contract No. 68-01-3259. Mr. Thomas E. Kopp was the Program Manager for the EPA throughout the performance of this work, and his patient support is gratefully acknowledged.

PCBs were first manufactured in commercial quantities in the U.S. in 1930, and during the next 40 years they were widely used as solvents, resins, and electrical dielectric liquids. Recognition of their environmental persistence and toxicity in the late 1960's eventually led to a ban on the manufacture and use of PCBs in the Toxic Substances Control Act of 1976. This report summarizes the use of PCBs and much of the early literature on the uses and toxicity of this material. In addition, the report reviews the regulatory actions that have been taken to limit the hazards to health and the environment resulting from the accumulation of PCBs in the environment and from their continued use in certain electrical equipment. The report is primarily a summary of the reports that Versar has prepared in support of the EPA's regulatory activities involving PCBs.

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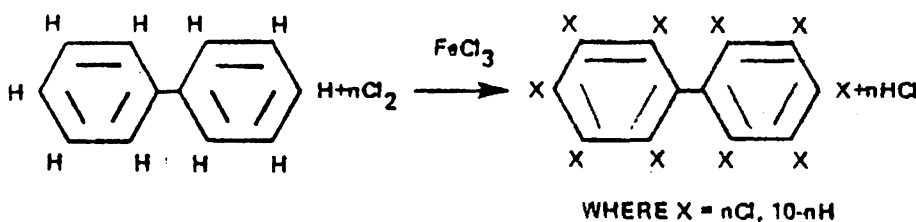
1.0 INTRODUCTION

On June 26, 1975, the U.S. Environmental Protection Agency awarded contract no. 68-01-3259 to Versar, Inc. Under this contract, it was anticipated that Versar would be assigned a number of tasks to assess the micro-economic impacts of regulatory alternatives which the EPA would consider for various toxic substances. The first task assigned under this contract required Versar to review and summarize the existing data on the use of polychlorinated biphenyls and to identify the industrial segments that might be impacted by regulations limiting the use of PCBs.

Before this task was completed, PCBs became a major issue within EPA, and the scope of the work assigned to Versar was increased as the agency required additional support. This report summarizes the work that Versar performed over the next four years for the EPA under the subject contract and a follow-on contract that was closely related to this work. All of this work supported regulatory activities involving PCBs, so the description of the work performed necessarily includes a history of the use of PCBs, a summary of regulatory development, and references to related research and reports.

2.0 POLYCHLORINATED BIPHENYLS

Polychlorinated biphenyls are a group of related compounds formed by the addition of chlorine to the aromatic hydrocarbon "biphenyl." The reaction can be described by the following equation:



2.1 History of PCB Usage:

PCBs were first synthesized and described in 1881 (Schmidt, 1881). Commercial production of PCBs did not become possible until after an economical method was developed during the 1920s for the manufacture of biphenyl from benzene.

Biphenyls were first produced in commercial quantities in the U. S. by Swann Research, Inc., of Anniston, Alabama. Shortly after they started manufacturing biphenyls, Swann Research described the manufacturing process (Jenkins, 1930) and the properties of the PCBs they were marketing under the tradename Aroclor (Penning, 1930). The various Aroclors were described as mixtures of chlorinated diphenyls with a wide range of properties from a light oil to a hard resin depending on the degree of chlorination. A number of commercial applications were suggested, including use in varnish, as a fireproofing agent for wood, in electrical equipment as a liquid dielectric and as a component of electrical insulation, as an ingredient in adhesives, as a replacement for Canada Balsam in microscopy, as a substitute for chicle in chewing gum, and in miscellaneous uses including printing inks and textile finishing (Penning 1930). A separate technical article described the compatibility of PCBs in nitrocellulose lacquer resins (Jenkins, 1931). The first major use of PCBs was apparently as a liquid dielectric in capacitors manufactured by General Electric Co. starting in 1930 (Clark, 1962). General Electric also developed the use of PCBs in other electrical applications as described in articles published during the 1930s (Clark, 1934; Clark, 1937).

PCBs were manufactured at the Anniston, Alabama, plant by Swann Research, Inc. and its corporate successor, Monsanto Chemicals Co., until the plant was shut down in 1971. Monsanto also manufactured PCBs at its plant at Sauget, Illinois, until 1977. The only other known U. S. manufacturer of PCBs was Geneva Industries of Houston, Texas, which manufactured PCBs for heat transfer applications from 1972 through 1974.

Most of the applications of PCBs that had been suggested in 1930 proved to be successful. PCBs were used as heat transfer liquids in critical applications such as food processing (Smith, 1955; Coulson, 1957), in various electrical applications (Clark, 1962), in sealants (Skrentny, 1971), in carbonless copy papers (Masuda, 1972; Lister, 1972), and in paint (Young, 1974). Polychlorinated terphenyls were suggested as a carrier for insecticides (Tsao, 1953; Sullivan, 1953). A Monsanto marketing guide to PCBs which was published in the late 1960s also described their possible use as expansion media in temperature sensing bellows devices, as liquid sealants for furnace roofs, as sealers for

gaskets, as dedusting agents, in insecticides, in casting waxes, in abrasives, in lubricants and cutting oils, in adhesives, in polishing waxes and impregnating compounds, in coatings, in inks, in mastics, in sealing and caulking compounds, in tack coatings, and as plasticizers in plastics, paint, varnish, and lacquer. (Monsanto, undated). In addition, a number of other uses of PCBs had been patented over the years (for a list of patents see: Interdepartmental Task Force on PCBs, 1972, pp. 70-74).

The available data on the toxicity of PCBs was first summarized in an article published in 1931 (Smyth, 1931). Skin problems attributed to PCB exposure were later reported to be associated with various industrial processes including PCB manufacturing (Jones, 1936), capacitor manufacturing (Mayers, 1936), industrial painting (Birmingham, 1942), and electrical cable insulating (Good, 1943). Systemic effects of exposure to mixtures of chlorinated organic compounds including PCBs were also noted during the 1930s (Drinker, 1937) and were evaluated by animal exposure studies (Bennett, 1938; von Wedel, 1943; Miller, 1944.) In much of this early work, the toxicity studies used commercial mixtures which included chlorinated naphthalenes, and the effects of PCBs were not conclusively demonstrated (Drinker, 1939). Animal exposure tests eventually defined the toxicity of PCBs (Treon, 1946; McLaughlin, 1963; American Industrial Hygiene Assoc., 1965), and reports of worker health problems became limited to unusual situations (i.e., Meigs, 1954). Information on the toxicity of PCBs led the investigation of PCBs as a possible cause of chick edema disease (McCune, 1962; Flick, 1965) which was later demonstrated to be caused by contamination of feed with chlorinated dibenzodioxins.

During the early 1960s interest increased concerning the biological effects of environmental levels of chlorinated pesticide residues such as DDT and chlordane. Measurement of low levels of these compounds in biological samples required the development of sensitive analytical procedures that could both separate the pesticides from each other and from similar compounds and measure the amount of each compound present. The technique that was developed to perform this analysis was gas chromatography. In this method, a small amount of sample is introduced into a long heated tube which is packed with a material that has

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different adsorption characteristics for the different compounds in the sample. The tube is then flushed with an inert gas, and the different compounds are swept out of the tube at different times past a detector that is sensitive to the presence of chlorinated organic compounds and that gives a response proportional to the amount of chlorinated material in the stream of inert gas. The time required for each compound to move through the tube depends on the temperature, the type of packing, the rate of flushing with inert gas, and the characteristics of the particular compound. Therefore, the identification of the compounds in the environmental sample depends on knowing the retention time of the compounds and the response of the detector to each compound. This requires that known compounds be run through the column and detector, and as a result, only known compounds can be identified. Gas chromatography proved to be a very useful method for determining the concentrations of low levels of pesticides in environmental samples, but the detector usually recorded the presence of a number of chemicals that could not be identified by comparison with known pesticide chemicals.

In 1966, Soren Jensen attempted to identify the unknown compounds that were being recorded during routine pesticide analyses. In order to determine when the unknown compounds first appeared in biological samples, he analyzed feathers, from eagles that had been taken for museum collections. He found the unknown materials in feathers collected as early as 1944, before the widespread use of chlorinated pesticides, and so concluded that the unknown materials were not pesticides or degradation products of pesticides (Jensen, 1972). By testing chlorinated materials that were in wide use before 1944, he eventually identified commercial PCBs as the source of the unknown compounds, and published this finding in late 1966 (Jensen, 1966).

A full discussion of the presence of PCBs in pesticide analyses was published in 1967 (Widmark, 1967), and this set off a number of investigations to determine the extent of environmental contamination by PCBs. The discovery that PCBs were common in the environment in sufficient concentrations to affect the reproduction of wild birds was published in 1968 (Risebrough, 1968). This article was picked up in the press which started the widespread concern about possible human health effects from PCBs in the environment.

The Yusho incident that occurred in Japan during the summer of 1968 added to the public concern over the toxicity of PCBs. This was a case of widespread PCB poisoning caused by contamination of cooking oil. The PCBs were used a heat transfer liquid on the high temperature side of a heat exchanger used to pasturize the oil. Over 1000 people were seriously affected by eating contaminated oil (Kuratsune, 1971). The resulting concern over PCBs led to regulatory activity and increased research throughout the world. In July of 1971, a similar incident in the United States contaminated a considerable quantity of chicken feed as the result of leakage of PCB heat transfer fluid. The U.S. Food and Drug Administration eventually destroyed thousands of chickens and eggs that were fed this contaminated feed (Pichirallo, 1971). Starting in 1970, Monsanto voluntarily limited sales of PCBs to closed electrical equipment applications (Wood, 1975) and recommended that existing PCB-filled heat transfer systems be drained and refilled with non-PCB fluid (Monsanto, 1972). This voluntary ban was completed by the end of 1973. Monsanto closed the Anniston, Alabama, manufacturing plant at this time.

By 1972, a great deal of research had been completed on PCBs and was summarized in various review articles covering their toxicity (Kimbrough, 1972; Kimbrough, 1974), environmental impact (Peakall, 1972; Hammond, 1972), environmental distribution (Nisbet, 1972), uses (Broadhurst, 1972), presence in food (Fries, 1972) and chemical analysis (Reynolds, 1971). The basic information on PCBs was later compiled in the monograph "The Chemistry of PCBs" (Hutzinger, 1974). The amount of published information on PCBs has continued to grow rapidly since the early 1970s and is now most accessible through published literature surveys (Fuller, 1976; Kornreich, 1976) and annotated bibliographies (Quinby, 1972; Office of Water Resources Research, 1973; Office of Water Research and Technology, 1975; Cavagnaro, 1978).

2.2 PCB Use Restrictions and Government Regulations

The Yusho incident created considerable concern in the U. S. over possible contamination of food by PCBs. The U. S. Food and Drug Administration started routine sampling of foods for PCBs in 1969, and soon found that PCBs

were present in fish from the Great Lakes, that there was PCB contamination of milk caused by use of PCBs as a solvent in pesticide sprays and as a component of sealants used in farm silos, and that there was contamination of chickens resulting from PCBs introduced into the feed as a component of ground bread cartons and wrappers. It has since become apparent that the presence of PCBs in fish is a problem that has existed since at least 1964 (Hartsough, 1965), although PCBs were not identified as the cause of the problem until 1971 (Aulerich, 1971; Aulerich, 1973).

From 1969 through 1971, the FDA established action levels for PCBs in food at 0.2 ppm in milk, 5 ppm in edible flesh of fish, 5 ppm in poultry, and 0.5 ppm in eggs. In 1970, the FDA prepared a summary of the available information on the chemistry and toxicity of PCBs (U. S. Department of Health, Education, and Welfare, 1970). In 1972, the FDA published a notice of proposed rulemaking (Federal Register, 37FR 5705). The U. S. Department of Agriculture also prepared a report on ways that it could act to limit PCB contamination of Food (U. S. Department of Agriculture Ad Hoc Group on PCBs, 1972.) In 1973, the FDA formally established limits for PCBs in food and animal feed (Federal Register, 38FR 18096). The FDA proposed a revision of these limits in 1977 (Federal Register, 42FR 17487), but no action has yet been taken on this proposal.

During 1970, the Council on Environmental Quality (CEQ) studied regulatory approaches to the problem of toxic chemicals in the environment. In its report "Toxic Substances" published in 1971, CEQ identified PCBs as a major problem (Council on Environmental Quality, 1971). The initial response of the responsible agencies was to establish a task force to review the available information on PCBs and recommend regulatory alternatives (Interdepartmental Task Force on PCBs, 1972).

During 1973 and 1974, the EPA proposed the establishment of water quality criteria for PCBs in industrial discharges as part of a program for establishing such criteria for a larger group of pesticides. However, PCBs were not covered in the effluent standards that were eventually promulgated.

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The Occupational Safety and Health Administration adopted the standards for PCB exposure in industrial air that had previously been established by the American Industrial Hygiene Association. The National Institute of Occupational Safety and Health conducted a major review of available data and an extensive program of industry assessment in the mid 1970s, and the final report recommended that the allowable concentration of PCBs in the work place be reduced (NIOSH, 1977). However, OSHA has not yet taken action on this recommendation.

Government actions restricting the use of PCBs were not limited to the United States. Japan banned the manufacture and use of PCBs in the early 1970s because of public pressure following the Yusho incident. Sweden banned the use of PCBs at about the same time. International actions were also taken to reduce the risk of food contamination by PCBs during the early 1970s (OECD, 1973; OECD Council, 1973; The Council of the European Communities, 1976).

3.0 CONTRACT SUPPORT OF EPA ACTIONS ON PCBs

3.1 Support of Office of Toxic Substances

During 1974 and 1975, the Office of Toxic Substances sponsored a series of review studies to identify regulatory alternatives for various specified toxic substances. Contract 68-01-3259 was awarded by the EPA to Versar on June 26, 1975, to support similar work on additional chemicals. The first task on this new contract was assigned by the EPA Technical Project Officer, Mr. David Garrett, on June 27, 1975. This task required the contractor to study the role of PCBs in the U.S. economy and prepare a draft report by October 31, 1975, identifying and screening alternative regulatory and non-regulatory control options: Study of Regulatory Alternatives for PCBs: Draft Interim Report - Task I, October 31. (Unpublished - Superseded by "PCBs in the United States...")

As part of the review of PCBs, the Office of Toxic Substances sponsored a national conference on PCBs in Chicago on November 19 thru 21, 1975.

The Technical Coordinator of this conference was Mr. Thomas Kopp of the Office of Toxic Substances. Several major articles on the environmental effects of PCBs that appeared in the popular press shortly before the conference (Boyle, 1975a; Boyle, 1975b) caused considerable public interest in the conference and a number of demands that EPA regulate PCBs. Dr. Robert Durfee of Versar participated in this conference and presented a paper summarizing the background on PCBs as presented in the draft report (Durfee, 1975).

Because of the increasing importance of PCBs to the activities of the Office of Toxic Substances after the conference, the EPA assigned Mr. Kopp as Technical Project Officer on the contract and had the contractor expand the draft interim report and prepare four special reports under Task I. The Versar Program Manager in charge of this work was Dr. Robert Durfee. The following reports were submitted in response to this directive:

The Handling and Disposal of Electric Transformers: Special Report, Task I (December 5, 1975). Non-proprietary sections included in "PCBs in the United States...."

Results from Review and Analysis of 308 Letter Responses on PCB Manufacturing, Usage, and Disposal in United States Industry: Special Report (December, 1975).

- * Toxicological Studies Conducted Under Task I: Special Report (February 19, 1976). Incorporated in "PCBs in the United States..." as Appendix F.
- * Development of an Economic Analysis Methodology for Evaluating Regulatory Alternatives for PCBs: Special Report, Task I (March 9, 1976). Unpublished.
- * PCBs in the United States: Industrial Use and Environmental Distribution - Final Report, Task I (February 25, 1976). EPA 560/6-76-005. NTIS PB 252 012.

At about the same time that Task I was expanded, the EPA directed the contractor to perform two additional tasks. Task II was a study of wastewater treatment technology that could be used to reduce the concentration of PCBs in industrial effluents. This work was supported by Clark, Dietz Associates who performed the industrial economic analysis under subcontract from Versar as provided by Modification 1 to the contract. Task III was a plan for an assessment of the use of PCBs

*See summary of report in Appendix C.

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in the investment casting industry and the resulting environmental impacts. Versar program managers were Mr. Donald Sargent on Task II and Dr. Robert Durfee on Task III. The following reports were submitted in response to these work directives:

- * Assessment of Wastewater Management, Treatment Technology, and Associated Cost for Abatement of PCBs Concentration in Industrial Effluents: Final Report, Task II. (February 3, 1976). EPA 560/6-76-006. NTIS PB 251-433/AS.
- * Development of a Study Plan for Definition of PCBs Usage, Wastes, and Potential Substitution in the Investment Casting Industry: Final Report, Task III. (January, 1976) EPA 560/6-76-007. NTIS PB 251-842.

Based on these three tasks and on other work performed within the Environmental Protection Agency, the EPA published recommended disposal procedures for PCBs (Federal Register, 41 FR 14134) and proposed effluent standards for PCBs in the water discharges from PCB manufacturers and from capacitor and transformer manufacturers that used PCBs (Federal Register, 41 FR 30468).

Senator Gaylord Nelson introduced an amendment to the Toxic Substances Control Act (TSCA) on March 26, 1976. This amendment required the EPA to establish labeling and disposal requirements for PCBs and mandated an eventual ban on the manufacture and processing of PCBs. This amendment was incorporated into TSCA as Section 6(e) and became a legislated requirement when TSCA was signed into law on October 11, 1976. The effective date of TSCA was January 1, 1977.

On July 15, 1976, EPA modified the contract to support additional studies on several aspects of PCBs. EPA technical supervision of this work was the responsibility of Mr. Kopp. Under this contract modification (Mod. 4), four formal tasks were established and two additional reports were prepared for internal EPA use. The Versar program manager for this work was Mr. Robert Westin, with each report being the responsibility of a Versar Task Manager who was as the principal author of the report. The following reports were submitted in response to the requirements of this contract modification:

*See summary of report in Appendix C.

- * PCBs Involvement in the Pulp and Paper Industry: Final Report, Task IV. EPA 560/6-77-005, NTIS PB 271-071/6WP. February 25, 1977.
- * A First Order Mass Balance Model for the Sources, Distribution, and Fate of PCBs in the Environment: Final Report, Task V. EPA 560/6-77-006, NTIS PB 270-220. July, 1977.
- * Assessment of the Environmental and Economic Impacts of the Ban on Imports of PCBs: Final Report, Task VI. EPA 560/6-77-007, NTIS PB 270-225. July 1977.
- * Assessment of the Use of Selected Replacement Fluids for PCBs in Electrical Equipment: Final Report, Task VII. EPA 560/6-77-008, NTIS No. forthcoming. April, 1979.

Environmental Discharges of PCBs Associated with the Manufacture and Use of PCBs and PCB-Containing Equipment. (Contains EPA proprietary information, submitted to EPA Enforcement Division.) October 29, 1976.

Usage of PCBs in Open and Semi-Closed Systems and the Resulting Losses of PCBs to the Environment. (Contains EPA proprietary information, submitted to EPA Enforcement Division). September 30, 1976.

3.2 Support of the Criteria and Standards Division

Versar provided support to the Criteria and Standards Division of EPA under three separate contract modifications. All of the work involved support of the effluent standards for PCBs by performing additional technical and economic analysis of the feasibility and costs of various pollution abatement technologies. The EPA Technical Program Manager on this work was Mr. Thomas Kopp, and the EPA Task Manager was Mr. Ralph Holtje of the Criteria and Standards Division. The Versar Program Manager was Mr. Donald Sargent. The contract modification requirements and the reports submitted were as follows:

Modification 2 (Feb. 27, 1976): Provided for the analysis of the economic impacts of the proposed regulation by Jack Faucett Associates under subcontract from Versar and for the review of the Final Task II report by Versar.

*See summary of report in Appendix C.

- * PCBs Water Elimination/Reduction Technology and Associated Costs: Manufacturers of Electrical Capacitors and Transformers: Addendum to Final Report, Task II. EPA 440/9-76-020. July 2, 1976.

Recommendations as to PCB Sampling Sites and Sampling Points at Industrial Sources: Special Report. August 17, 1976.

- * Economic Analysis of Proposed Toxic Pollutant Effluent Standards for Polychlorinated Biphenyls: Transformer, Capacitor, and PCB Manufacturing. (Prepared by Jack Faucett Associates) EPA 230/1-76-068. October, 1976.

Modification 3 (June 10, 1976): Provided for additional assessment of wastewater management and treatment technology and support of EPA during formal hearings and rulemaking proceedings.

- * Costs for U.V. - Ozonation Process: Addendum to Final Report, Task II. September 27, 1976. Unpublished.
- * Detailed Cost Estimates for Alternative PCBs Treatment Technologies Applied to Hypothetical Large and Medium Sized PCB Capacitor and Transformer Manufacturing Plants. Addendum to Final Report, Task II. October 15, 1976. Unpublished.
- * Cost for Equalization Basin Based on Bentonite Clay Liner Special Report, October, 1976. Unpublished.
- * Impacts of Substitutes for PCBs on Fire Hazards in Commercial and Residential Buildings: (Draft) Special Report. October, 1976. Unpublished.
- * Recent Advances in PCBs Detoxification in Wastewater: Supplement to Final Report, Task II. January 18, 1977. Unpublished.
- * PCB Levels in Non-Contact Cooling Waters and Other Effluents from Capacitor and Transformer Production Facilities: Supplement to Final Report, Task II. January 18, 1977. Unpublished.
- * Refinement of Alternative Technologies and Estimated Costs for Reduction of PCBs in Industrial Wastewaters from the Capacitor and Transformer Manufacturing Categories. January 19, 1977. Unpublished.
- * Costs Associated with Installing Production Equipment for Use of Non-PCB Dielectric Fluids in Transformer and Capacitor Manufacture: Supplement to Final Report, Task II. January 19, 1977. Unpublished.

*See summary of report in Appendix C.

On February 2, 1977, the EPA promulgated effluent standards restricting any discharges of PCBs in the wastewaters from manufacturers of PCBs or from capacitor and transformer manufacturing plants that used PCBs after February 2, 1978 (Federal Register, 42 FR6531).

3.3 Support of PCB Work Group - Disposal and Marking Regulations

Section 6(e)(1) of the Toxic Substances Control Act required the EPA to regulate the labeling and disposal of PCBs by July 1, 1977. On December 8, 1976, the EPA announced the formation of a PCB Work Group to write the proposed rules. The contractor provided staff support to this work group, providing a number of special reports as requested, performing the economic impact analysis of the proposed regulation, and providing testimony at the rulemaking hearing. The contract was modified on March 25, 1977, (Mod. 6) to authorize this additional technical and economic support. The EPA Project Officer for this work was Mr. David Wagner, and Mr. Thomas Kopp remained the Technical Project Officer in charge of the total contract. The Versar Program Manager was Mr. Robert Westin. The following reports were submitted in support of the development of the PCB Marking and Disposal Regulations:

Assessment Methodology for Labeling and Education to Assure the Proper Disposal of PCBs: Special Report. November, 1976.

Analysis of the Economic and Technological Constraints on the Disposal of PCBs: Special Report. November 22, 1976.

PCB Disposal Regulations: Problem Areas and Regulatory Alternatives: Special Report. December 10, 1976.

Estimated Usage of Electrical Equipment Containing PCBs: Special Report. December 23, 1976.

Recommended Label Requirements and Suggested Label Formats: Special Report. January 12, 1977.

Draft Notice of Public Meeting - PCBs. January 10, 1977.

Comments on PCB Definitions to Subcommittee on Manufacturing Bans. January 14, 1977.

*See summary in Appendix C.

Draft Notice of Proposed Rulemaking, Preamble, and Labeling and Disposal Regulations: Special Report. January 21, 1977; revised February 4, 1977.

Labeling and Disposal Regulations: Revised Draft. January 27, 1977.

Draft Preamble to PCB Disposal Regulation. December 29, 1976; revised January 12, 1977; revised February 4, 1977.

Economic Impact - Summary and Conclusions: Special Report. March 14, 1977.

Statement of Economic Consequences of the Rule: Special Report. April 12, 1977.

- * Microeconomic Impacts of the Proposed Marking and Disposal Regulations for PCBs. April, 1977. EPA 560/6-77-013, NTIS PB 267-933.

EPA formally proposed the rules for marking and disposal of PCBs on May 24, 1977 (Federal Register, 42 FR 26564). Rulemaking hearings were held on June 24, 27, 28, and 29. Mr. Westin of Versar presented testimony on the economic impacts of the proposed regulation at the hearings on June 29. The EPA promulgated the PCB Disposal and Marking Regulations on February 17, 1978 (Federal Register, 43 FR 7150) and issued corrections on August 2, 1978 (Federal Register, 43 FR 33918). The effective date of the regulations was April 18, 1978.

3.4 Support of PCB Work Group - PCB Ban Regulations

Sections 6(e)(2) and 6(e)(3) of the Toxic Substances Control Act banned the manufacturing, processing, distribution, and use of PCBs after January 1, 1978, except in a totally enclosed manner; completely banned the manufacture of PCBs after January 1, 1979; and completely banned the processing and distribution in commerce of PCBs after July 1, 1979. However, the Act also authorized the EPA to exempt those activities involving PCBs that did not present an unreasonable risk of injury to health or the environment provided

*See summary in Appendix C.

that good faith efforts were made to develop an adequate substitute for PCBs in that use. On June 27, 1977, the EPA announced the formation of a PCB work group to develop proposed regulations implementing these provisions of the act, and announced public meetings on the subject to be held in Washington, D.C. on July 19, 1977 (Federal Register, 42 FR 32555).

EPA modified the contract on June 26, 1977, (Mod. 7) to provide for support during the development of the proposed ban regulations. EPA Project Officers continued to be Mr. Wagner and Mr. Kopp. Versar's work was supervised by Mr. Westin. Versar prepared briefing papers for the work group prior to the public meetings and submitted them to the work group as the special report: Potential Impacts of the Bans on PCB Manufacturing, Processing, and Use: PCB Activity Analysis Papers (July 11, 1977).^{*} Following the public meetings, the work group prepared a draft of the proposed regulations (August 30, 1977), and the contractor submitted a formal report on the economic impacts of these regulations: Microeconomic Impacts of the Draft "PCB Ban Regulations": Draft Report (September 18, 1977). Formal proposal of the ban regulations was delayed while the Work Group prepared the final version of the Disposal and Marking Regulations, and on December 30, 1977, EPA announced that it would not enforce the January 1, 1978 ban on open system activities involving PCBs until after formal ban regulations were promulgated (Federal Register, 42 FR 65264).

The work group continued to revise the draft proposed regulation, and Versar submitted a major revision of the economic impact analysis reflecting the changes in the proposed regulation and including appendices characterizing the U.S. waste oil industry and presenting a formal microeconomic analysis of the supply and demand effects of the PCB Ban on the electric equipment industry: Microeconomic Impacts of the Draft "PCB Ban Regulations": Revised Draft Report (March 8, 1978).^{*}

3.5 Support of EPA Office of Planning and Management - PCB Ban Regulations

In early 1978, the EPA transferred responsibility for the analysis of the economic impacts of the PCB ban regulations from the PCB Work Group to the

^{*}See summary in Appendix C.

Office of Planning and Management. On April 19, 1978, the EPA awarded contract number 68-01-4771 to Versar for additional economic analysis, preparation of a revision of the previously submitted draft economic impact report, and support during the public hearings on the proposed regulations. The EPA Technical Project Officer was Mr. Steven B. Malkensen, Office of Planning and Management. The Versar Program Manager was Mr. Robert Westin. In May, 1978, the contractor submitted the revised report: Microeconomic Impacts of the Proposed "PCB Ban Regulations"* that was issued in support of the proposed regulations as EPA Report No. EPA-560/6-77-035.

The EPA formally proposed the PCB Ban Regulations on June 7, 1978 (Federal Register, 43 FR 24801). Public Hearings were held in Washington, D. C., from August 21 through September 1, 1978. Mr. Westin of Versar presented testimony on the economic impacts of the proposed regulations on September 26, 1978.

Following the hearings, EPA continued to revise the ban regulations. On November 1, 1978, EPA published interim procedural rules for filing and processing petitions for exemptions from the January 1, 1979 bans on manufacturing of PCBs (Federal Register, 43 FR 50905). On January 2, 1979, EPA announced that it would not enforce the prohibitions on PCB manufacturing, processing, distribution in commerce, and use until after formal promulgation of the PCB Ban Regulations (Federal Register, 44 FR 108).

On November 15, 1978, Versar submitted a draft report on the economic impacts of the draft ban regulations: PCB Manufacturing, Processing, Distribution in Commerce, and Use Ban Regulation: Economic Impact Analysis: Draft Final Report. A major revision of this report was submitted on December 22, 1978. On December 27, 1978, EPA modified contract 68-01-4771 to extend the duration of the contract and to fund further revisions of the economic impact analyses as required by additional changes to the draft regulation. Mr. Stephen Weil was assigned to be the EPA Technical Project Officer for this contract modification. The contractor submitted the final revision of this

*See summary in Appendix C.

report on March 30, 1979.* EPA issued the final regulations on April 19, 1979. Formal promulgation of the regulations through the Federal Register was expected to occur by the end of May, 1979.

*See summary in Appendix C.

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