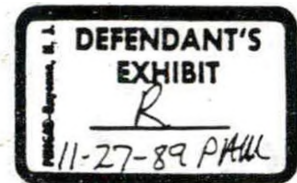


criteria for a recommended standard....

**OCCUPATIONAL EXPOSURE
TO
POLYCHLORINATED BIPHENYLS
(PCBs)**



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

SEPTEMBER 1977

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DHEW (NIOSH) Publication No. 77-225

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PREFACE

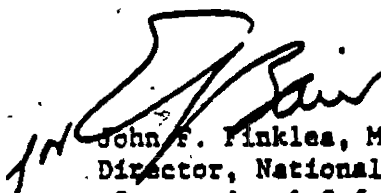
The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. The National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices, to provide relevant data from which valid criteria for effective standards can be derived. Recommended standards for occupational exposure, which are the result of this work, are based on the health effects of exposure. The Secretary of Labor will weigh these recommendations along with other considerations such as feasibility and means of implementation in developing regulatory standards.

It is intended to present successive reports as research and epidemiologic studies are completed and as sampling and analytical methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on polychlorinated biphenyls by members of the NIOSH staff and the valuable, constructive comments by the Review Consultants on polychlorinated biphenyls, by the ad hoc committees of the Society for Occupational and Environmental Health and the American Occupational Medical Association, and

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by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on polychlorinated biphenyls. A list of Review Consultants appears on page vi.



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The Division of Criteria Documentation and Standards Development (DCDSD), National Institute for Occupational Safety and Health, had primary responsibility for the development of the criteria and recommended standard for polychlorinated biphenyls. From DCDSD, John M. Fajen served as criteria manager and developed the basic information with the assistance of John A. Wass, Ph.D. Personnel from other NIOSH Divisions that assisted in the development of this document were Robert H. Hill Jr., Ph.D., Alan K. Gudeman, and Dennis M. O'Brien (Division of Physical Sciences and Engineering); Mark W. Jones (Division of Surveillance, Hazard Evaluations and Field Studies); and Trent R. Lewis, Ph.D. (Division of Biomedical and Behavioral Science).

The DCDSD review of this document was provided by Richard A. Rhoden, Ph.D., Chairman; J. Henry Wills, Ph.D.; and Howard L. McMartin, M.D., with A. Blair Smith, M.D. (Division of Surveillance, Hazard Evaluations and Field Studies), and James H. Sterner, M.D.

The views expressed in this document, the conclusions reached, and the recommendations for a standard are those of NIOSH after review of the evidence and consideration of the comments of reviewers. These views and conclusions are not necessarily those of the consultants, other federal agencies, and professional societies that reviewed the document.

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**CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN OCCUPATIONAL
EXPOSURE STANDARD FOR POLYCHLORINATED BIPHENYLS**

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I. RECOMMENDATIONS FOR A POLYCHLORINATED BIPHENYLS (PCBs) STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that employee exposure to polychlorinated biphenyls (PCBs) in the workplace be controlled by adherence to the following sections. The standard is designed to protect the health and provide for the safety of employees for up to a 10-hour workday, 40-hour workweek, over a normal working lifetime. The standard is measurable by techniques that are valid, reproducible, and available to industry and governmental agencies. Compliance with the standard should substantially reduce any risk of reproductive or tumorigenic effects of PCBs and prevent other adverse effects of exposure in the workplace. Employees should regard the recommended workplace environmental limit as the upper boundary for exposure and make every effort to keep exposure as low as possible.

Evidence indicates adverse reproductive and tumorigenic effects in experimental animals exposed to certain commercial PCB preparations. Currently available information is not adequate to demonstrate that other commercial PCB preparations do not have these effects. Should sufficient information become available to indicate that the standard offers greater or lesser protection from some chlorobiphenyl isomers or commercial preparations than is needed, it will be considered for revision.

The Toxic Substances Control Act of 1976 (Public Law 94-469) required the US Environmental Protection Agency (EPA) to prescribe marking and disposal regulations for PCBs by July 1, 1977 (Federal Register 42:26563-77, May 24, 1977). By this Act, the manufacture, processing, distribution

in commerce, or use of PCBs in any but totally enclosed systems is to be banned, effective 1 year after the date of its enactment, October 11, 1976. Two years after the enactment date PCB manufacture is to be banned, and processing and distribution in commerce are to be banned 2.5 years from that date. However, the Act allows the Administrator of EPA to rule otherwise if he finds that manufacture, processing, distribution in commerce, or use in other than totally enclosed systems will not present an unreasonable risk of injury to health or to the environment. The Act does not affect use of equipment already containing PCBs in totally enclosed systems, so that a potential for occupational exposure to PCBs will continue to exist for many years as a consequence of their transportation, installation, use, and disposal. The part of the Act specific for PCBs is presented in Figure I-1.

"PCBs" are defined for this recommended standard as commercial preparations of chlorinated biphenyl compounds, including those preparations which may be described as single isomers or classes of isomers, such as Decachlorodiphenyl. Biphenyl and its monochlorinated derivatives occurring in commercial preparations of PCBs shall be measured along with the polychlorinated derivatives, and shall be treated in this standard as the polychlorinated components of the preparations. "Occupational exposure to PCBs," is defined as working with PCBs or with equipment containing PCBs that can become airborne or that can spill or splash on the skin or into the eyes, or the handling of any solid products that may result in exposure to PCBs by skin contact or by inhalation. The term "PCB work area" is defined as an area where there is occupational exposure to PCBs. In areas where no occupational exposure to PCBs occurs,

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but where PCBs are present in equipment in the workplace, adherence is required only to Section 8(a).

Section 1 - Environmental (Workplace Air)

(a) Concentration

Occupational exposure to polychlorinated biphenyls (PCBs) shall be controlled so that no worker is exposed to PCBs at a concentration greater than 1.0 microgram total PCBs per cubic meter of air (1.0 $\mu\text{g}/\text{cu m}$), determined as a time-weighted average (TWA) concentration, for up to a 10-hour workday, 40-hour workweek.

(b) Sampling and Analysis

The recommended TWA occupational exposure limit for PCBs has been determined to be the lowest reliably detectable limit by the sampling and analytical methods recommended in this document. Environmental samples shall be collected and analyzed as described in Appendices I and II, or by any methods shown to be at least equivalent in accuracy, precision, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available to all employees subject to occupational exposure to PCBs.

(a) Preplacement or initial medical examinations for workers shall include:

(1) Comprehensive medical and work histories with special emphasis on hepatic function, skin condition, and reproductive history.

(2) Comprehensive physical examination with particular attention to the skin and to hepatic function including determinations of serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) activities. The responsible physician may also wish to obtain measurements of serum triglyceride concentrations or of other indices of fat metabolism.

(3) A judgment of the employee's ability to use positive pressure respirators.

(b) During examinations, applicants or employees having medical conditions that could be directly or indirectly aggravated by exposure to polychlorinated biphenyls or formulations containing polychlorinated biphenyls shall be counseled on the increased risk of impairment of their health that might result from working with these substances.

(c) Women in the work force who are of child-bearing age shall be advised of the potential adverse effects of PCBs on the unborn child. Those who bear children while working with PCBs shall be counseled concerning the advisability of nursing their babies.

(d) Initial medical examinations shall be made available to all workers as soon as practicable after promulgation of a standard based on these recommendations.

(e) Periodic examinations shall be made available at least annually and include: (1) interim medical and work histories, and (2) physical examinations as outlined in paragraphs (a)(1) and (a)(2) of this section.

(f) If evidence of adverse effects of exposure to PCBs is suspected or confirmed, appropriate medical care shall be made available to the affected worker(s).

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(g) Pertinent medical records shall be maintained for all employees exposed to PCBs in the workplace. Such medical records shall be maintained for the period of employment plus 30 years. These records shall be made available to the designated medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, of the employer, and of the employee or former employee.

Section 3 - Labeling and Posting

All labels and warning signs shall be printed both in English and in the predominant language of non-English-reading workers. Illiterate workers and workers reading languages other than those used on labels and posted signs shall be otherwise informed regarding hazardous areas and shall be informed of the instructions printed on labels and signs.

(a) Labeling

The following warning label shall be affixed in a readily visible location on PCB-processing or other equipment, and on PCB-storage tanks or containers:

POLYCHLORINATED BIPHENYLS
(PCBs)

DANGER! CONTAINS POLYCHLORINATED BIPHENYLS
CANCER SUSPECT AGENT

Use only with adequate ventilation.
Do not get in eyes, or on skin or clothing.

First Aid: In case of skin or eye contact, flush with running water.

(b) Posting

Warning placards shall be affixed in readily visible locations in or near PCB work areas. The information contained thereon shall be arranged as in the following example.

POLYCHLORINATED BIPHENYLS
(PCBs)

DANGER!

CANCER SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY

Do not enter unless area is adequately ventilated.

Do not get in eyes, or on skin or clothing.

First Aid: In case of skin or eye contact, flush with running water.

Section 4 - Personal Protective Equipment and Clothing

(a) Protective Clothing

In any operation where workers may come into direct contact with PCBs, protective clothing impervious to PCBs shall be worn. Gloves, boots, overshoes, and bib-type aprons that cover boot tops shall be provided when necessary. Protective apparel shall be made of materials which most effectively prevent skin contact with PCBs where it is most likely to occur. Employers shall ensure that all personal protective clothing is inspected regularly for defects and that it is in a clean and satisfactory condition.

(b) Eye Protection

Chemical safety goggles, face shields (8-inch minimum) with goggles, or safety glasses with side shields shall be provided by employers and shall be worn during any operation in which PCBs are present. If liquid or

solid PCBs contact the eyes, the eyes shall be irrigated immediately with large quantities of water and then examined by a physician or other responsible medical personnel. (A drop of vegetable oil on the eye has been found to reduce the resultant irritation.) Eye protection shall be in accordance with 29 CFR 1910.133 and ANSI Z 87.1-1968.

(c) Respiratory Protection

(1) Engineering controls shall be used when needed to keep concentrations of airborne PCBs at or below the recommended TWA occupational exposure limit. The only conditions under which compliance with the permissible exposure limit may be achieved by the use of respirators are:

(A) During the time necessary to install or test the required engineering controls.

(B) For nonroutine maintenance or repair activities.

(C) During emergencies when concentrations of airborne PCBs may exceed the permissible limit.

(2) When the use of respirators is permitted by paragraph c(1) of this section, respirators shall be selected and used in accordance with the following requirements:

(A) The employer shall establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134.

(B) The employer shall provide respirators in accordance with Table I-1 and shall ensure that employees properly use the respirators provided. The respirators shall be those approved by NIOSH or the Mining Enforcement and Safety Administration. The standard for approval is specified in 30 CFR 11. The employer shall ensure that

respirators are properly cleaned, maintained, and stored when not in use.

TABLE I-1

RESPIRATOR SELECTION GUIDE

Concentration of PCBs	Respirator Type Approved under Provisions of 30 CFR 11
Greater than 1.0 $\mu\text{g}/\text{cu m}$ or <u>Emergency</u> (entry into area of unknown concentra- tion)	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode. (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode and an auxiliary self-contained breathing apparatus operated in pressure demand or other positive pressure mode.

Section 5 - Informing Employees of Hazards from PCBs

(a) All new and present employees in any area in which PCBs are used shall be informed of the hazards, relevant symptoms, and effects of overexposure to PCBs, and the precautions to be observed for safe use and handling of these materials.

(b) All employees involved with the manufacture, use, transport, or storage of PCBs shall be informed that PCBs have been found to induce tumors in experimental animals after repeated oral ingestion and that because of these findings it is concluded that PCBs are potential human carcinogens; employees shall also be informed that adverse reproductive

effects may result from occupational exposure to PCBs.

(c) The employer shall institute a continuing education program, conducted by instructors qualified by experience or training, to ensure that all employees occupationally exposed to PCBs have current knowledge of job hazards, proper maintenance and cleanup methods, and proper use of protective clothing and equipment, including respirators. The instructions shall include a general description of the medical surveillance program and of the advantages to the employee of participation. Special attention shall be given to women in the workplace. They shall be made aware of the potential adverse effects of PCBs on the unborn child, and of the known transport of PCBs to breast milk. Elements of the program shall also include:

- Emergency procedures and drills;
- Instruction in handling spills and leaks;
- Decontamination procedures;
- Firefighting equipment location and use;
- First-aid procedures, equipment location, and use;
- Rescue procedures;
- Confined space entry procedures;
- Low warning (odor) properties of PCBs.

(d) The information explaining the hazards of working with PCBs shall be kept on file and be readily accessible to workers at all places of employment where PCBs are manufactured, used, stored, or transported. Required information shall be recorded on the "Material Safety Data Sheet" shown in Appendix III, or similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices and Engineering Controls

(a) Regulated Areas

Access to PCB work areas shall be regulated and limited to authorized persons. A daily roster shall be kept of persons entering such areas.

(b) Handling of PCBs and General Work Practices

(1) Operating instructions shall be formulated and posted where PCBs are handled or used.

(2) Transportation and use of PCBs shall comply with all applicable local, state, and federal regulations.

(3) PCBs shall be stored in tightly closed containers in well-ventilated areas.

(4) When PCB storage containers are being moved, or when they are not in use and are disconnected, valve protection covers shall be in place. Containers shall be moved only with the proper equipment and shall be secured to prevent dropping or loss of control during transport.

(5) Storage facilities shall be designed to contain spills completely within surrounding dikes and to prevent contamination of workroom air.

(6) Ventilation switches and emergency respiratory equipment shall be located outside storage areas in readily accessible locations which will remain minimally contaminated with PCBs in an emergency.

(7) Process valves and pumps shall be readily accessible and shall not be located in pits or congested areas.

(8) Containers and systems shall be handled and opened with care. Approved protective clothing as specified in Section 4 shall be worn

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by employees engaged in opening, connecting, and disconnecting PCB containers and systems. Adequate ventilation shall be provided to minimize exposures of such employees to airborne PCBs.

(9) PCB-operating and storage equipment and systems shall be inspected daily for signs of leaks. All equipment, including valves, fittings, and connections shall be checked for leaks immediately after PCBs are introduced therein.

(10) When a leak is found, it shall be repaired or otherwise corrected immediately. Work shall resume normally only after necessary repair or replacement has been completed, the area has been ventilated, and the concentration of PCBs has been determined by monitoring to be at or below the recommended TWA concentration limit.

(c) Control of Airborne PCBs

(1) Suitable engineering controls, designed to maintain exposure to airborne PCBs at or below the limit prescribed in Section 1(a), shall be used. Complete enclosure of processes is the recommended method for control of PCB exposure. Local exhaust ventilation may also be effective, used alone or in combination with process enclosure. When a local exhaust ventilation system is used, it shall be so designed and operated as to prevent accumulation or recirculation of airborne PCBs in the workplace environment and to effectively remove PCBs from the breathing zones of employees. Exhaust ventilation systems discharging to outside air must conform to applicable local, state, and federal regulations and must not constitute a hazard to employees or to the general population. Before maintenance work on control equipment begins, the generation of airborne PCBs shall be eliminated to the extent feasible.

Enclosures, exhaust hoods, and ductwork shall be kept in good repair so that designed airflows are maintained. Airflow at each hood shall be measured at least semiannually and preferably monthly. Continuous airflow indicators are recommended, such as water or oil manometers properly mounted at the juncture of fume hood and duct throat (marked to indicate acceptable airflow). A log shall be kept showing design airflow and the results of semiannual airflow measurements.

(2) Forced-draft ventilation systems shall be equipped with remote manual controls and shall be designed to shut off automatically in the event of a fire in the PCB work area.

(d) Special Work Areas

(1) PCB Hazard Areas

A hazard area shall be considered as any space having physical characteristics and containing sources of PCBs, such as transformers, that could result in PCB concentrations in excess of the recommended airborne PCB exposure limit. Exits shall be plainly marked, conveniently located, and open outwardly into areas which will remain minimally contaminated in an emergency.

(2) Confined or Enclosed Spaces

Entry into confined or enclosed spaces, such as tanks, pits, process vessels, and tank cars where there is limited egress, shall be controlled by a permit system. Permits shall be signed by an authorized representative of the employer and shall certify that appropriate measures have been taken to prevent adverse effects on the worker's health as a result of his or her entry into such space.

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Confined or enclosed spaces which have contained PCBs shall be thoroughly ventilated to assure an adequate supply of oxygen, tested for PCBs and other contaminants, and inspected for compliance with these requirements prior to each entry. Adequate ventilation shall be maintained while workers are in such spaces. Leakage of PCBs into such confined or enclosed spaces while work is in progress shall be prevented by disconnecting and blanking the PCB supply lines. Each individual entering such confined or enclosed space shall be furnished with appropriate personal protective equipment and clothing and be connected by a lifeline harness to a standby worker stationed outside of the space. The standby worker shall also be equipped for entry with approved personal protective equipment and clothing and have contact with a third person. The standby person shall maintain communication (visual, voice, signal line, telephone, radio, or other suitable means) with the employee inside the confined or enclosed space.

(e) Emergency Procedures

For all PCB work areas where there is a potential for the occurrence of emergencies, employers shall take all necessary steps to ensure that employees are instructed in, and follow, the procedures specified below as well as any others appropriate to the specific operation or process.

(1) If PCBs leak or are spilled, the following steps shall be taken:

(A) All nonessential personnel shall be evacuated from the leak or spill area.

(B) The area of the leak or spill shall be adequately ventilated to prevent the accumulation of vapors.

(C) If the PCBs are in liquid form, they shall be collected for reclamation or sorbed in vermiculite, dry sand, earth, or similar nonreactive material.

(2) Personnel entering the spill or leak area shall be furnished with appropriate personal protective equipment and clothing. All other personnel shall be prohibited from entering the area.

(3) Only personnel trained in the emergency procedures and protected against the attendant hazards shall shut off sources of PCBs, clean up spills, control and repair leaks, and fight fires, in areas where PCBs are used.

(4) All wastes and residues containing PCBs shall be collected in PCB-resistant containers and appropriately disposed of (Federal Register 42:26563-77, May 24, 1977).

(5) Safety showers, eyewash fountains, and washroom facilities shall be provided, maintained in working condition, and located so as to be readily accessible to workers in all areas where the occurrence of skin or eye contact with PCBs is likely. If liquid or solid PCBs are splashed or spilled on an employee, contaminated clothing shall be removed promptly and the skin washed thoroughly with soap and water for at least 15 minutes. Eyes shall be irrigated immediately with copious quantities of running water for at least 15 minutes if liquid or solid PCBs get into them. A drop of vegetable oil may be applied to the eye to relieve the irritating effect of PCBs.

Section 7 - Sanitation Practices

(a) Employees occupationally exposed to PCBs shall be provided

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with separate lockers or other storage facilities for street clothes and for work clothes.

(b) Employees occupationally exposed to PCBs shall not wear work clothing away from their place of employment.

(c) Employees occupationally exposed to PCBs shall be provided clean work clothing daily, and cleaning establishments shall be informed as to the hazards of handling PCBs and proper disposal procedures for PCB-contaminated waste water.

(d) Facilities for shower baths shall be provided for employees occupationally exposed to PCBs. Workers should shower before changing into street clothes.

(e) Employees exposed to PCBs shall be advised to wash their hands and exposed skin before eating, drinking, smoking or using toilet facilities during the work shift.

(f) Food, drink, or smoking materials shall not be permitted in areas where PCBs are handled, processed, or stored.

Section 8 - Monitoring and Recordkeeping Requirements

(a) Monitoring

(1) As soon as practicable after the promulgation of a standard based on these recommendations, each employer who manufactures, processes, handles, stores or otherwise uses PCBs shall determine by an industrial hygiene survey whether occupational exposure to PCBs may occur. Surveys shall be repeated at least once every year and within 30 days of any process change likely to result in occupational exposure to PCBs. Records of these surveys, including the basis for any conclusion that there

may be no occupational exposure to PCBs, shall be retained until the next survey has been completed.

(2) If occupational exposure to PCBs is determined to be possible, a program of personal monitoring shall be instituted to measure or permit calculation of the exposures of all employees.

(A) In all personal monitoring, samples representative of the employees' breathing zones shall be collected.

(B) For each TWA concentration determination, a sufficient number of samples shall be taken to characterize each employee's exposure during each work shift. Variations in work and production schedules and in employees' locations and job functions shall be considered in choosing sampling times, locations, and frequencies.

(C) Each operation in each work area shall be sampled at least once every 3 months.

(3) If an employee is found to be exposed to PCBs in excess of the recommended TWA concentration limit, control measures shall be initiated, the employee shall be notified of the exposure and of the control measures being implemented to correct the situation, and the employee shall be monitored every 30 days. Such monitoring shall continue until two such consecutive determinations indicate that the employee's exposure no longer exceeds the recommended TWA concentration limit. Routine monitoring may then be resumed.

(b) Recordkeeping

Environmental monitoring records shall be maintained for at least 30 years after the employee's last occupational exposure to PCBs. These records shall include the dates and times of measurements, job function and

location of employees within the worksite, methods of sampling and analysis used, types of respiratory protection in use at the time of sampling, TWA concentrations found, and identification of exposed employees. Each employee shall be able to obtain information on his or her own environmental exposures. Daily rosters of authorized persons who enter regulated areas shall be retained for 30 years. Environmental monitoring records and entry rosters shall be made available to designated representatives of the Secretary of Labor and of the Secretary of Health, Education, and Welfare.

Pertinent medical records for each employee shall be retained for 30 years after the employee's last occupational exposure to PCBs. Records of environmental exposures applicable to an employee should be included in that employee's medical records. These medical records shall be made available to the designated medical representatives of the Secretary of Labor, of the Secretary of Health, Education, and Welfare, of the employer, and of the employee or former employee.

(e) **POLYCHLORINATED BIPHENYLS.**—(1) Within six months after the effective date of this Act the Administrator shall promulgate rules to—

Rules.

(A) prescribe methods for the disposal of polychlorinated biphenyls, and

(B) require polychlorinated biphenyls to be marked with clear and adequate warnings, and instructions with respect to their processing, distribution in commerce, use, or disposal or with respect to any combination of such activities.

Requirements prescribed by rules under this paragraph shall be consistent with the requirements of paragraphs (2) and (3).

(2) (A) Except as provided under subparagraph (B), effective one year after the effective date of this Act no person may manufacture, process, or distribute in commerce or use any polychlorinated biphenyl in any manner other than in a totally enclosed manner.

(B) The Administrator may by rule authorize the manufacture, processing, distribution in commerce or use (or any combination of such activities) of any polychlorinated biphenyl in a manner other than in a totally enclosed manner if the Administrator finds that such manufacture, processing, distribution in commerce, or use (or combination of such activities) will not present an unreasonable risk of injury to health or the environment.

(C) For the purposes of this paragraph, the term "totally enclosed manner" means any manner which will ensure that any exposure of human beings or the environment to a polychlorinated biphenyl will be insignificant as determined by the Administrator by rule.

"Totally enclosed manner."

(3) (A) Except as provided in subparagraphs (B) and (C)—

(i) no person may manufacture any polychlorinated biphenyl after two years after the effective date of this Act, and

(ii) no person may process or distribute in commerce any polychlorinated biphenyl after two and one-half years after such date.

(B) Any person may petition the Administrator for an exemption from the requirements of subparagraph (A), and the Administrator may grant by rule such an exemption if the Administrator finds that—

Petition for exemption.

(i) an unreasonable risk of injury to health or environment would not result, and

(ii) good faith efforts have been made to develop a chemical substance which does not present an unreasonable risk of injury to health or the environment and which may be substituted for such polychlorinated biphenyl.

An exemption granted under this subparagraph shall be subject to such terms and conditions as the Administrator may prescribe and shall be in effect for such period (but not more than one year from the date it is granted) as the Administrator may prescribe.

Terms and conditions.

(C) Subparagraph (A) shall not apply to the distribution in commerce of any polychlorinated biphenyl if such polychlorinated biphenyl was sold for purposes other than resale before two and one half years after the date of enactment of this Act.

(4) Any rule under paragraph (1), (2) (B), or (3) (B) shall be promulgated in accordance with paragraphs (2), (3), and (4) of subsection (c).

(5) This subsection does not limit the authority of the Administrator, under any other provision of this Act or any other Federal law, to take action respecting any polychlorinated biphenyl.

FIGURE I-1. SECTION 6(e) OF THE TOXIC SUBSTANCES CONTROL ACT

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational disease and injury arising from workplace exposure to PCBs. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970, to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultations with others, formalized a system for the development of criteria upon which standards can be established to protect the health and to provide for the safety of employees exposed to hazardous chemical and physical agents. Criteria and recommended standards should enable management and labor to develop better engineering controls resulting in more healthful work environments. Mere compliance with the recommended standard should not be used as a final goal.

These criteria for a standard for PCBs are part of a continuing series of criteria developed by NIOSH. The recommended standard applies to the processing, manufacture, and handling of PCBs as applicable under the Occupational Safety and Health Act of 1970. The standard was not designed for the population-at-large, and any application to situations other than occupational exposures is not warranted. It is intended to (1) protect

against acute and chronic PCB poisoning, (2) be measurable by techniques that are available to industry and official agencies, and (3) be attainable with existing technology.

The standard is designed to substantially reduce the risk of development of carcinogenic, adverse reproductive, hepatotoxic, and dermatologic effects. Since 1970, PCBs have been one of the more thoroughly investigated environmental and occupational hazards. Nevertheless, there are important gaps in the knowledge of chronic exposure effects in man at low concentrations of PCBs. Important research needs include studies on the reproductive histories of women who have been exposed to PCBs, and quantitation of the dermal and respiratory absorption of different mixtures of PCBs. A better understanding is needed of the contaminants in commercial PCB preparations, particularly studies to determine the extent to which any chlorinated dibenzofurans in tissues of PCB-exposed American workers result from direct absorption or are derived from PCBs in the body. Another need is for an assessment of the hazards associated with the mobilization, during fasting or in other abnormal physiologic states, of PCBs stored in the body.

III. BIOLOGIC EFFECTS OF EXPOSURE

Extent of Exposure

Biphenyl ($C_{12}H_{10}$), diagrammed in Figure III-1, can be chlorinated by replacing any or all of its hydrogen atoms with chlorine [1].

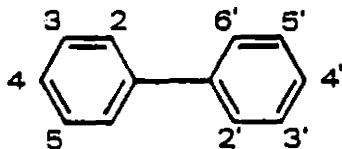
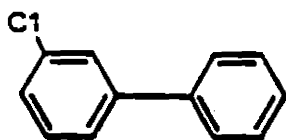
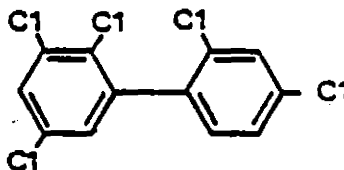


Figure III-1. BIPHENYL MOLECULE AND RING NUMBERING SYSTEM

Specific chlorobiphenyl molecules are designated by reference to the positions of the chlorine atoms according to the numbering scheme depicted in Figure III-1. The lowest possible numbers are assigned, and the phenyl moiety with the fewest chlorine atoms is assigned prime numbers [1,2]. Examples of the nomenclature used here are shown in Figure III-2.



3-chlorobiphenyl



2,2',3,4',5-pentachlorobiphenyl

Figure III-2. EXAMPLES OF NOMENCLATURE SYSTEM OF CHLOROBIPHENYL COMPOUNDS

There are three monochlorobiphenyl compounds, 2-, 3-, and 4-chlorobiphenyl. The 5- and 6-monochlorobiphenyls are identical to 3- and 2-monochlorobiphenyl, respectively. There are 18 dichlorobiphenyl

compounds. The number of possible chlorobiphenyl isomers and the corresponding weight-percents of chlorine are presented in Table III-1.

TABLE III-1

NUMBER OF ISOMERS AND PERCENT CHLORINE
FOR THE 10 CHLOROBIPHENYL (PCB) CLASSES

Chlorobiphenyl	Empirical Formula	No. of Isomers	Weight % Cl
mono	C ₁₂ H ₉ Cl	3	18.79
di	C ₁₂ H ₈ Cl ₂	12	31.77
tri	C ₁₂ H ₇ Cl ₃	24	41.30
tetra	C ₁₂ H ₆ Cl ₄	42	48.56
penta	C ₁₂ H ₅ Cl ₅	46	54.30
hexa	C ₁₂ H ₄ Cl ₆	42	58.93
hepta	C ₁₂ H ₃ Cl ₇	24	62.77
octa	C ₁₂ H ₂ Cl ₈	12	65.98
nona	C ₁₂ HCl ₉	3	68.73
deca	C ₁₀ Cl ₁₀	1	71.18

Adapted from reference 1

In the commercial synthesis of chlorobiphenyls, biphenyl is catalytically chlorinated with anhydrous chlorine; either iron filings or ferric chloride may be used as the catalyst [1]. The commercial preparations, commonly referred to as "PCBs," are isomeric mixtures. The weight-percent chlorine in commercial mixtures has generally varied between 21 and 68% and has been used to designate grades of commercial products. Commercial PCB products manufactured in the US, Great Britain, and Japan have been marketed under the trade name "Aroclor" [1-3]. Several grades of Aroclor have been designated by numbers such as 1221, 1242, 1254, and 1260, where the last two digits represent the percent by weight of chlorine in

the mixtures. Another grade of Aroclor, 1016, made primarily of tri- and tetrachlorobiphenyl compounds and containing 41% chlorine by weight, was introduced in 1971 to replace Aroclor 1242 [2,4,5]. Other PCB products manufactured in Japan were marketed as "Santotherm" [1], and "Kanechlors" 300, 400, 500, and 600, containing approximately 42%, 48%, 54%, and 60% chlorine, respectively [6]. In Germany, products marketed as "Clophens" A50 and A60 contained 54 and 60% chlorine, respectively [7]. In France, PCBs were marketed as "Phenoclors" and "Pyralenes;" Phenoclor DP6 contains 60% chlorine [8]. Other countries reported to have produced PCBs are Italy, Spain, Czechoslovakia, Poland, Argentina, Brazil, the USSR, and India [1,9,10].

The chlorobiphenyl constituents of several commercial PCB products have been studied [6-8,11-16]. Some data, both qualitative and quantitative, are presented in Table XII-2. About half the 209 possible chlorobiphenyls do not occur in any of the commercial preparations. Among those compounds which do not occur, or which occur in trace amounts only, are 3-chlorobiphenyl, all of the tri- to pentachloro compounds that are chlorinated in only one ring, the penta-, hexa-, and heptachloro compounds that are completely chlorinated in one ring, and the penta- and hexachloro compounds that are chlorinated in four positions in one ring.

Commercial PCBs are insoluble in water, but are soluble in oil and many organic solvents. Some other physical and chemical properties of certain Aroclor products are presented in Table XII-1 [1].

In addition to chlorinated biphenyls, the commercial mixtures with 20-40% chlorine contained biphenyl from about 11% to traces, respectively, by weight. Many commercial PCB products also contain chlorinated

dibenzofurans [17-23] and naphthalenes [18,19]. Concentrations of chlorinated dibenzofurans in various commercial PCB products are presented in Table III-2.

TABLE III-2

CHLORODIBENZOFURAN TYPES AND CONCENTRATIONS ($\mu\text{g/g}$)
IN COMMERCIAL PCB PREPARATIONS

Mixture*	Chlorodibenzofurans						Total	Ref.
	di	tri	tetra	penta	hexa	hepta		
(1) 1016	0.5						0.5	**
(1) 1016			<0.001	<0.001	<0.001			21
(1) 1248			0.5	1.2	0.3		2.0	21
(1) 1254			0.1	0.2	1.4		1.7	21
(1) 1254			0.2	0.4	0.9		1.5	21
(1) 1260			0.1	0.4	0.5		1.0	21
(1) 1260			0.2	0.3	0.3		0.8	21
(2) A-60			1.4	5.0	2.2		8.4	21
(3) DP-6			0.7	10.0	2.9		13.6	21
(4) K300			(a)	(a)			1-1.5	20
(4) K400	(c)***	(a)	(a)	(c)			17-18	20
(4) K500				(a)	(c)	(a)	2.5-4	20
(4) K600			(a)	(a)	(b)	(b)	3-5	20

*(1) Aroclor, (2) Clophen, (3) Phenoclor, (4) Kanechlor

** (I Pomerantz, written communication, January 1977)

*** (a), (b), (c), (d), (e) represent relative amounts in increasing order

Some commercial preparations that were marketed under the trade name Aroclor contained chlorinated terphenyls in addition to chlorinated biphenyls. Aroclors 2565 and 4465 contained 75% and 60% chlorinated biphenyl compounds and 25% and 40% chlorinated terphenyl compounds, respectively. Both mixtures contained 65% chlorine [1].

A broad class of nonflammable synthetic chlorinated hydrocarbon insulating liquids used in electrical capacitors, transformers, nuclear

reactors, and accessory equipment is designated by the generic term "askarel" [4,5,24,25]. PCBs have been major components of most askarels used in the US since 1932. Two general classes of PCB-containing askarels are "capacitor"-grade and "transformer"-grade [4,5]. Aroclor 1242 was the major capacitor impregnant in the US before 1971; subsequently, Aroclor 1016 has been used mainly for this purpose [4]. Transformer-grade askarels manufactured in the US include those marketed under trade names including "Asbestol," "Chlorextol," "Inerteen," "No-Flamol," "Pyranol," and "Saf-T-Kuhl" [4]. Transformer-grade askarels are usually mixtures of trichlorobenzene and more highly chlorinated (42-60%) biphenyls [5,24]. Some typical compositions are: 100% Aroclor 1242; 70% Aroclor 1254 and 30% trichlorobenzene; 60% hexachlorobiphenyl and 40% trichlorobenzene; 45% hexachlorobiphenyl and 55% trichlorobenzene; and 70% pentachlorobiphenyl and 30% trichlorobenzene. Another type of transformer-grade askarel contains 45% polychlorinated biphenyl (54% chlorine) and 55% of a mixture of tri- and tetrachlorobenzenes. Transformer-grade askarels also contain stabilizers such as glycidyl phenyl ether and 3,4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate [24].

Exposure to commercial preparations of PCBs in the work environment may involve many different chlorinated biphenyl compounds, and also substantial amounts of biphenyl, tri- and tetrachlorobenzenes, and small amounts of many different chlorinated dibenzofurans, chlorinated naphthalenes and in special uses, chlorinated terphenyls.

Commercial production of PCBs in the US began in 1929 and reached 85 million pounds in 1970 when the major producer began selling PCBs only for use in "closed" systems. Since 1972, only those Aroclors designated 1016,

1221, 1242, and 1254 have been produced in the US, and total annual production has been around 40 million pounds [26].

Imported PCBs amounted to about a half-million pounds in 1972 and 1973 [26,27]. A decachlorobiphenyl produced in Italy and imported by one company for use in investment casting waxes accounted for 80-90% of the total PCB imports [26]. The other 10-20% was imported from France for use in semiclosed heat transfer applications [27]. Occupational exposure to decachlorobiphenyl could occur in the manufacture of the investment casting waxes as well as in the preparation of the investment casting molds in the 25 US foundries which use the decachlorobiphenyl wax [26].

Most of the PCBs produced in the US since 1971 have been used in electrical capacitors (70%) and transformers (30%). About 95% of the 100 million capacitors produced annually in the US contain PCBs [27]. There is potential occupational exposure to PCBs in the plants of the 17 reported companies that manufacture capacitors in the US. Capacitors are generally classified into two categories for disposal purposes. "Small" capacitors contain less than 2 pounds of PCBs; those incorporated into electrical equipment such as television sets, home air conditioners, and light fixtures contain 2-340 ml of PCBs and have service lives of at least 10 years [26,28]. "Large" capacitors may contain about 25 liters of PCBs [26] and have a service life of 15-20 years [26,27]. Potential occupational exposures exist in the servicing of appliances and in the disposal of used capacitors or equipment.

Transformers that contain PCBs are used mainly in or near inhabited buildings where fire hazards from cheaper oil-filled transformers are greatest. The estimated 135,000 PCB-containing transformers represent

about 5% of all transformers in the US [27]. Occupational exposure to various askarels used for transformers may occur in their manufacture, servicing, and transportation, or as a result of leaks [29].

Other potential occupational exposures to PCBs exist through losses in storage [30], shipment [29], manufacture and use of heat exchange units [27,31], and in use of previously manufactured items which contain PCBs, such as hydraulic systems, vacuum pumps, and gas transmission turbines [30,31]. The past use of PCBs in carbonless copying papers may result in exposure of workers currently engaged in paper reclamation [30]. Workers in plants that previously used PCBs may have current exposure in their working environments because PCBs have been shown to remain in the workplace air and on surfaces for years after PCB use has been discontinued [32,33]. Several occupations that may have involved exposure to PCBs were tabulated in a 1966 publication [34]. NIOSH estimates that 12,000 workers have potential occupational exposure as a result of current uses of PCBs in their working environments [35].

In addition to their occupational exposures, PCB workers may be exposed to PCBs carried into their homes from the workplace [36], from general contamination of the ambient air [26,37,38] and water [26,37], and to PCBs and their metabolites in their diets [39-46].

Metabolism and Mechanism of Action

A study of the metabolism of 4-chlorobiphenyl was reported in 1959 by Block and Cornish [47]. In this experiment, 1 gram of 4-chlorobiphenyl was fed to rabbits in a single dose and 4'-chloro-4-biphenylol and its

glucuroniside were recovered from the urine in amounts that accounted for 24 and 50%, respectively, of the administered dose.

Subsequently, a substantial number of metabolic studies of individual chlorobiphenyl compounds [41-43,48-84], mixtures [85,86], and metabolites [48,49,87] were reported, and a comprehensive review was published in 1976 [88]. These reports collectively demonstrate through many study methods that some aspects of metabolism are of special significance to the toxicity of PCBs and that some isomers are more toxic, or have different effects, than others [89-94].

Chlorinated biphenyl compounds are readily absorbed from the digestive tract, regardless of the degree or pattern of chlorine substitution [50,51,95,96]. It seems likely that similar absorptive characteristics apply to the respiratory system since chlorobiphenyl mixtures in air are rapidly absorbed [97], as is decachlorobiphenyl [98,99]. Varying amounts of chlorobiphenyls, depending on degree and pattern of chlorination, are excreted in the feces [42,50,53-56,100], milk [41-44,51,101], and hair [102] of animals, but no more than trace amounts are excreted in the urine [42,51-55,57-62,103-105].

Metabolites of chlorobiphenyl compounds have been found in the urine of mammals including mice [52], rats [48,53-56,58-60,63,64,66,71,85], rabbits [63,67-69], monkeys [51,61,74,75], swine [72], goats [73], and cows [41,73], as well as in feces [48,50-54,56,58-65,76-80], and milk [41]. The metabolites excreted in urine [53,54,58,59,61,63,64,66,67], bile [50,51,53,81], feces [52-54,58,63,76], and milk [41] are, to varying degrees, conjugated with glucuronic or sulfuric acids. Differences in metabolism of PCBs among the aforementioned species are more quantitative

than qualitative [51,73]; however, metabolism in birds and fish may differ qualitatively from that in mammals [55,77]. Among mammals there are also quantitative differences in PCB metabolism and in effects related to age and sex [50,93,106]. Metabolites identified in mammals include mono- to polyhydroxylated derivatives [41,48,49,51-56,58-81,85], and methoxy [59,60], hydroxymethoxy [64,65,68,70,76,87], dihydrodihydroxy [51,53,54,69,74,75,81], hydroxydihydrodihydroxy [51,74], and dechlorinated derivatives [48,65,70,77].

The lower-chlorinated biphenyl compounds are more readily metabolized than are the more highly chlorinated ones [41,50,51,55,61-64,66,82-84,96,107-109], with no metabolism having been demonstrated for decachlorobiphenyl [66]. As a consequence, some of the more highly chlorinated compounds persist in the tissues for years after intake has been discontinued [51,83,103,110].

The presence of at least two adjacent, unsubstituted hydrogen atoms, particularly in positions 3, 4, and 5, or 3', 4', and 5', is required for rapid metabolism of chlorobiphenyls [79,83,84]. All mono-, di-, and trichlorobiphenyls, and all tetrachlorobiphenyls except 3,3',5,5'-tetrachlorobiphenyl meet this requirement. The latter compound, 3,3',5,5'-tetrachlorobiphenyl, was found to be particularly toxic to monkeys, and it was suggested that the chlorinated dibenzofuran derivative may have been involved [94]. While dibenzofuran derivatives have not been demonstrated to exist as mammalian metabolites, they may have been identified as PCB metabolites in chickens [111] and Curley et al [22] reported the excretion of dibenzofurans in urine of rats. In the latter case, however, dibenzofurans were also identified in the administered PCB [22].

Dibenzofurans are of concern because they may be many times more toxic than PCBs [19,112].

Metabolites found in urine [48,51,53,56,60,61,64,66-74,85], bile [81], feces [51-53,56,58,60,61,64,66,76,79,80,113], and milk [41] include hydroxy derivatives. Such compounds have been demonstrated to be more toxic than their respective parent chlorobiphenyl [41,114] and their presence in milk [41] is of special concern.

Hydroxylation may be direct through hydroxylating enzyme systems, or through formation of arene oxide intermediates [48,51,53,68,75,81,87,115]. This latter process is of particular concern because of potential carcinogenesis and mutagenesis as a result of covalent binding of arene oxides to nuclear components of the cell [51,68,74,82,86,116]. Such binding has been demonstrated both in vivo [51,86] and in vitro [51,82,86,116,117]. Additional evidence of hydroxylation through arene oxide intermediates included findings of metabolites in which chlorine, deuterium, or tritium were at different molecular locations than in the administered compound [68,115,116,118], and transdihydrodiols as mammalian metabolites [51,69,74,75,81].

Although adjacent unsubstituted hydrogen atoms are necessary for rapid metabolism of chlorinated biphenyls, it has been demonstrated that 2,2',4,4',3,5'-hexachlorobiphenyl, which does not have this characteristic, can be hydroxylated [70,79], and oxidatively dechlorinated [65,70]. It has been proposed that the metabolism of this compound may also involve arene oxide formation [65], and chronic exposure to potential carcinogenic activity of resulting arene oxides [86] may result from the metabolism of this and similar compounds [75].

Historical Reports

Smyth [119], in a paper read October 28, 1930, presented the results of his studies with biphenyl, 2- and 4-chlorobiphenyl, and two unidentified polychlorobiphenyl mixtures. He reported the oral minimum lethal doses for rabbits and guinea pigs as 4+, 2.5, 3.5, 4+, and 4+ g/kg, respectively.

Health problems associated with the manufacture of PCBs were the subject of a report by Jones and Alden [120] in 1936. The case history was presented of a man whose employment, from April 1930 to the end of 1933, involved the distillation of chlorobiphenyl. In May 1933 he developed chloracne, a specific type of acne known to be caused by some chlorinated hydrocarbon compounds [121,122]. Jones and Alden [120] stated that the manufacturing process was not enclosed, that a different source of benzene (a starting ingredient) had been used from the summer of 1932 through October 1933, and that from March to October 1933, the dielectric qualities of the PCBs produced had been substandard. Of 24 men working in the manufacturing process during the period beginning in the summer of 1932, 23 developed chloracne. The first indication of chloracne in the workers appeared in January 1933. Following another change in the source of benzene, enclosure of the distillation apparatus and installation of ventilation fans, a gradual improvement in the acneiform eruptions was noted.

In 1936, Schwartz [123] reported digestive disturbances, burning of the eyes, and impotence in men working with chlorobiphenyls. He also noted that nonachlorobiphenyl was used as an insulator for automobile electric wires, in capacitors, and as a delusterer of rayon.

A000040

An early use of PCBs was for incorporation along with chloronaphthalenes into synthetic waxes [124-128]. These waxes contained 10-20% PCBs [124-126] and were used to insulate electrical wire and cable. There were several reports that chloracne [125-128] developed in workers involved in the manufacture and use of these waxes, which were associated with at least one fatality in 1936 [125,127].

The fatal case was described by Drinker et al [125] in 1937. The patient, who had been exposed to low concentrations of tetra- and pentachloronaphthalenes (90%) and chlorinated biphenyls (10%) developed chloracne, followed by jaundice. He was hospitalized with abdominal pain and distention. At autopsy, cirrhosis of the liver with superimposed acute yellow atrophy was found. Two other fatal cases were described where the exposures had been to mixtures of penta- and hexachloronaphthalenes [125]. According to the authors, no similar cases had been reported in the literature. As a result of these fatalities, estimates of the airborne concentrations of chlorinated hydrocarbons in 30 different factories were made and animal experiments were performed to study the effects of exposure at such concentrations.

Rats were exposed 16 hours/day, 6 days/week to trichloronaphthalenes at 1.31 mg/cu m, to a mixture of penta- and hexachloronaphthalenes at 1.16 mg/cu m, to a mixture of penta- and hexachloronaphthalenes (90%) and chlorinated biphenyls (10%) at 1.37 mg/cu m, and to a chlorinated biphenyl mixture containing 64% chlorine at 0.57 mg/cu m. The authors [125] stated that higher concentrations had frequently been found in the factories, and that except for trichloronaphthalenes, they did not consider that it would be safe to expose workers to any of the mixtures at the concentrations

During July 1972 through June 1974, 2,324 fat samples were analyzed by the Human Monitoring Survey, 1,277 in the first year and 1,047 in the second [136]. In the 2 years, respectively, PCBs were not detected in 24.5 and 9.1%, were present at <1 ppm in 40.2 and 50.6%, were present at >2 ppm in 5.5 and 4.9%, and were present at 1-2 ppm in the remainder of the samples. Penta-, hexa-, and heptachlorobiphenyl were the PCBs most frequently present.

A complete analysis of PCB compounds in a composite sample of adipose tissues from patients at the University Hospital in Lund, Sweden, was reported by Jensen and Sundstrom [7] in 1974. Forty-five compounds, accounting for the total PCB content of the adipose tissues, were found and identified by comparison with known PCB isomers. The biphenyl compounds included three tetrachloro isomers, many penta-, hexa-, hepta-, octa-, and nonachloro isomers, and decachlorobiphenyl. By comparison with Clophens A50 and A60, which had compositions similar to Aroclors 1254 and 1260, respectively, the authors [7] found the relative concentration of several compounds with chlorine substitution in the 4,4' positions of the biphenyl ring to have occurred, as did many compounds without vicinal, unsubstituted positions. Most of the compounds which underwent relative dilution to the greatest extent had either vicinal, unsubstituted 3,4-positions or two pairs of vicinal, unsubstituted positions.

Blood sera of 616 residents of urban and rural areas of South Carolina were analyzed for PCBs and the results were presented by Finkles et al [137] in 1972. Analysis was accomplished by GLC with a Ni-63 electron capture detector after basic dehydrochlorination. The amounts of PCBs present were estimated by integration of five peak areas associated

water [26,37], and in many foods [39,45,46]. A common dietary intake of 10-20 µg/day has been estimated for teenage males in the US [46]. PCBs frequently have been found in various tissues and body fluids of the US population, eg, at ppm concentrations in adipose tissue [7,36,134-136], ppb concentrations in blood [137,138,140,141], and in milk [143,144] at ppm or ppb concentrations in the milk fat or whole milk, respectively.

The Environmental Protection Agency's Human Monitoring Survey has analyzed human adipose tissue samples collected since late 1968 for PCB content [134]. According to this 1972 report, 637 samples had been analyzed, and 198 of these contained more than 1 ppm of PCBs. Positive findings were made in tissues from each of the 18 participating states.

A detailed analysis of two samples collected in the Human Monitoring Survey was made by gas-liquid chromatography (GLC) and mass spectrometry (MS) and reported by Biros et al [135] in 1970. The samples contained at least 14 isomers ranging from penta- to decachlorobiphenyls. Price and Welch [36] stated that of more than 4,000 human adipose tissue samples examined by the Michigan State Department of Health Pesticides, none had chromatograms that exactly matched those of standard Aroclor solutions. Their data show relative accumulation in adipose tissue of the more highly chlorinated compounds, and relative dilution or absence of the less highly chlorinated compounds originally present in Aroclors 1254 and 1260. They [36] described the analyses of tissue samples at autopsy of a 77-year-old man in which PCB concentrations of 100-250 ppm (fat basis) were found. The highest PCB concentration was in the liver. The authors [36] found about 55% of adipose tissue samples in the general population contained PCBs at <1.0 ppm, about 36% at 1-2 ppm, and the remainder at more than 2 ppm.

and 600. The data suggested nonselective in utero transfer of PCB compounds from mother to fetus. Concentrations of PCBs in human embryonic and fetal tissues were reported by Shiota et al [139] in 1973 to not exceed those found in postnatal individuals who died accidentally. The concentrations, found in 19 embryos 5-8 weeks old, were reported as <2 ppb. The concentrations found in 5 second trimester and 2 third trimester fetuses are presented in Table III-4, expressed on the bases of both whole tissue and on the fat content of the tissue.

TABLE III-4

CONCENTRATIONS (ppb) OF PCBs IN TISSUES OF HUMAN FETUSES

Age of Placental Contents	Basis	Tissue Analyzed			
		Cerebrum	Liver	Kidney	Skin
2nd trimester	Whole	2-23	2-33	6-20	17-83
	Fat	150-60	230-800	60-1,900	550-1,300
3rd trimester	Whole	2*	25-90	6-10	48-769
	Fat	270*	1,000-1,300	420-470	880-1,400

*One sample

Adapted from reference 139

PCB concentrations in the venous blood of nine patients hospitalized with severe wasting diseases were reported by Hasselberg and Scherr [140] in 1974. The investigators were concerned with the release of stored organo-halide pesticides and PCBs during mobilization of body fat. They were unable to detect any PCBs in the blood of 15 apparently healthy

with Aroclors 1254 and 1260. PCBs were not present in samples from all individuals in quantities measurable by the technique used (Table III-3). Analysis of the data indicated that measurable serum PCB concentrations were not related to the age (<5 to >60 years) or sex (305 females, 311 males) of the donor, but that the concentrations associated with race and residence (Table III-3) were statistically different.

TABLE III-3

PCB CONCENTRATIONS IN BLOOD SERUM BY RACE AND RESIDENCE

Race and Residence	No. in Sample	PCBs Measureable In		PCB Concentrations	
		No.	%	Ave* ppb	Max ppb
Rural black	107	5	4.67	9.45	20.6
Urban black	151	57	37.75	5.22	29.0
Rural white	192	119	61.98	5.12	16.6
Urban white	166	89	53.61	4.38	22.0

*Average of measurable concentrations

Adapted from reference 137

Maternal and cord blood samples collected in Tokyo, Japan from December 1973 through February 1974 were reported in 1975 by Akiyama et al [138] to contain PCBs at mean concentrations of 2.8 and 1.1 ppb, respectively (on a whole blood basis). The maximum concentrations found were 7.6 ppb in maternal blood and 3.3 ppb in cord blood. Quantitatively, significant correlations of PCB concentrations in 21 pairs of maternal and cord blood samples were not found. Qualitatively, pairs of maternal and cord bloods had identical PCB patterns resembling those of Kanechlors 500

There were differences in chromatographic patterns between individuals, but for each individual the chromatographic patterns for the adipose tissue and the milk were qualitatively the same. PCBs in all samples contained principally 4-8 chlorine substitutions. Although the basis (fat or whole milk) for expressing the concentration of PCBs in the milk was not stated, comparisons with PCB concentrations found in adipose tissue and milk by other investigators indicate that the whole milk basis was used [136,144] (EP Savage, written communication, February 1977). Concentration data are summarized in Table III-5.

TABLE III-5

PCBS IN MILK AND ADIPOSE TISSUE OF FOUR WOMEN

Subject	PCB Concentrations, ppm	
	Adipose Tissue	Milk
a	0.62	0.008
b	0.75	0.015
c	1.6	0.032
d	3.1	0.036

Adapted from reference 143

Concentrations of PCBs measured in milk samples from 39 women living in two small cities in Colorado were presented by Savage et al [144] in 1973. Two samples contained PCBs at concentrations of 0.05 and 0.1 ppm. Six other samples contained PCBs at 0.04 ppm, the lower limit of detection for the analytical method, or less. The time postpartum at which the samples were collected and the basis (fat or whole milk) for expressing the concentrations were not mentioned. (Comparison with data in the following

control subjects. PCB concentrations found in the patients' blood (uncorrected for efficiency of recovery) ranged from 10 to 100 ppb. Information was not presented on the patients' occupations etc prior to their having become ill.

PCB concentrations in blood plasma and in adipose tissue samples obtained from 28 people during routine abdominal sections had a correlation coefficient of 0.74 according to Inoue et al [141]. The average concentration of PCBs was 6.1 ± 3.52 ppb in blood plasma, and in the adipose tissue (fat basis) it was 2.6 ± 1.9 ppm. These investigators [141] also evaluated the effect of emaciation on PCB concentrations in blood plasma of these and other patients; they found an average of 8.4 ± 4.26 ppb in 19 emaciated patients and 4.7 ± 2.17 ppb in 30 unemaciated patients.

Hair samples collected from a college barber shop were reported by Matthews et al [102] in 1976 to contain PCBs at 0.34-0.76 ppm. The samples were composites from five or more individuals collected on two occasions, 4 months apart. Hair was collected from the barber shop aprons, and care was taken to avoid possible contamination. Five commercial preparations of hair sprays, shampoos, and hair clipper lubricating oil were negative for PCBs. Blood samples were not collected for comparison.

PCBs were reported in 1966 to have been found in hair samples from three members of a Swedish family [142], but no concentration data were given. It was speculated that one of the family members, a 5-year-old girl, had acquired PCBs from her mother's milk.

A correlation was found between the quantities and compositions of PCBs in samples of adipose tissue collected from four women during Caesarean deliveries and in milk samples collected 3-5 days later [143].

(approximately 450 each) were registered in Fukuoka and Nagasaki prefectures as of September 1973 [161]. In the prefectures of Hiroshima, Kochi, and Yamaguchi, there were 80, 45, and 40 cases, respectively, at that time. In each of the other 17 prefectures there were 1-25 registered cases. The total number of cases registered by March 1970 was 1,015; by September 1973, the number had increased to 1,200, and by May 1975 to 1,291 [161,162]. The disease became known as "Yusho," or rice oil disease [145,163]. The outstanding signs of the poisoning were acneiform eruptions and eye discharges (a peculiar secretion from the meibomian glands) [146]. Chloracne was suspected [164]. Hyperpigmentation of the skin, nails, and mucous membranes, swelling of the upper eyelids, and hyperemia of the conjunctivae were other common signs [146,165].

Studies of the rice oils consumed by the patients indicated that the oil associated with Yusho was produced mainly during February 1968 [147,148]. The source of the contamination was determined to be a heat exchange unit containing PCBs that leaked through tiny holes when rice bran oil was heated at low pressure to remove odorous constituents [163,165]. By intensive chemical analyses, including infrared spectrophotometry and GLC, the major contaminant in the rice bran oil was found to be Kanechlor 400 [147]. PCB concentrations in the oil varied, depending on the date of production or shipment. The highest concentration of PCBs, based on the chlorine content of the oil, was about 3,000 ppm which was found in canned oil shipped on February 5. GLC data were not quantitated. In oils shipped thereafter, PCB concentrations decreased rapidly, and only traces were found in oils produced after February 19, 1968 [147,148]. Minor contaminants in the rice oil included polychlorinated dibenzofurans at

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paragraph suggests that the whole milk basis was used.)

Results of analyses of 384 human milk samples from 40 states for PCBs were presented in a written communication by EP Savage in February 1977. All positive samples that contained PCBs at less than 50 ppb on a whole milk basis were recorded as a "trace." Samples with 50 ppb or more of PCBs were reported as ppm in milk fat on the basis of 2.8% milk fat. Only five samples were not positive for PCBs, and 112 samples from 27 states contained measurable amounts (up to 12.6 ppm on a fat basis). Of the total number of samples, 141 were analyzed during December 1976 and January 1977. The time postpartum when the samples were collected was not stated.

While no adverse effects have been associated with PCBs at the concentrations found in adipose tissue, blood, or milk of individuals whose only known exposures were from general environmental contamination [7,36,102,136-144], knowledge of these concentrations is important to the evaluation of reports on occupational exposures. That is, the data provide a basis for evaluating body burdens of PCBs added by occupational exposure and indicate that workers may have substantial body burdens before the added insult of occupational exposure.

(b) Effects from Consuming PCB Contaminated Rice Bran Oil

An episode of poisoning associated with PCB ingestion occurred in Japan in 1968, and was the subject of a special issue of the journal *Fukuoka Acta Medica* in June 1969 [145-159]. These reports dealt primarily with the situation in Fukuoka prefecture where 325 poisoning cases had been identified through January 20, 1969. The episode resulted from consumption of a particular brand of rice bran oil [160] and ultimately involved persons in 22 prefectures [161]. About equal numbers of cases

about 1/200 of the PCB concentration [20,160], traces of chlorinated naphthalenes, and bromine at about 2% of the chlorine content [147]. Recent analyses of some of the oil samples indicate that there may have been other chlorinated organic contaminants (F Cordle, written communication, November 1976).

In one study [148], the contaminated rice bran oil was found to have been used largely for frying food (which may have altered the constituents). The oil was consumed for various periods during the spring through October 1968 [148]; the first reported clinical examination of a Yusho patient had occurred on June 7, 1968 [163]. Studies through January 1969 of patients in Fukuoka prefecture indicated that onsets of Yusho began as early as February and as late as December 1968, and first involved the eyes [146]. Onset occurred in most patients in June, July, and August [146].

Some attempts were made to estimate the amounts of rice oil and PCBs consumed by the patients [166,167]. Maximum consumption of oil was estimated at 4.4 liters [166]. Isono and Fujiwara [167] estimated that two Yusho cases may have resulted from the ingestion of PCBs at a daily rate of 67 $\mu\text{g/kg}$ body weight for 3 months. For 146 Yusho patients who lived in homes known to have used oil shipped on February 5-6, the estimated average total oil consumption was 800 ml, a volume that contained an estimated 2 g of PCBs [166]. It was estimated that the maximum volume of oil consumed by an individual was 2.7 liters. Of 21 patients who had consumed more than 1,400 ml (3-4 g of PCBs), 18 were considered to have had major signs of Yusho. Among 80 patients estimated to have consumed less than 720 ml of the oil, 31 were thought to have had major signs of Yusho. From the same

data, the minimum PCB ingestion among the 146 patients was estimated at 0.5 g [165]. Estimates of the amount of contaminated oil consumed by 13 pregnant women during the ingestion period ranged from 300 to 2,600 mg [167], but estimates of their PCB consumption were not made. Of the 13 babies born to these women, 8 had jaundice, 3 had marked dermal chromopexy, and 9 had excess secretion of tears [167].

Several studies of PCBs in the tissues and body fluids of Yusho patients were made at various intervals after ingestion of the contaminated oil [146,147]. The samples taken closest to the time of ingestion were collected in October and November 1968 [146,147]. Samples from discharges of the acneiform eruptions of two patients contained PCBs at 32 and 45 ppm, and samples of subcutaneous fat from the face and abdomen of an 18-year-old man contained PCBs at about 75 and 13 ppm, respectively. PCBs with GLC patterns similar to those of the contaminated oil were found in these samples as well as in placental and fetal tissues [147]. Preserved tissues from a baby that had been stillborn in October 1968 were later analyzed and PCB concentrations of 1.8, 1.2, and 0.1 ppm in fat were found in the liver, skin, and fat, respectively [168]. The baby's mother had been classified as a severe case of Yusho with onset about mid-June, but the amount of oil consumed, the period of pregnancy during which it was consumed, and the body burden of the mother were not reported [149]. PCBs were found in all sputum samples from 13 patients collected between December 1969 and May 1970 [169,170]. PCB concentrations were highest in December and detection was less common by May.

Other data on concentrations of PCBs were obtained from body fat and other tissues taken from five Yusho patients at autopsy [168,171]. The

dates of death were between July 1969 and May 1972. Cause of death was heart failure in four cases and a ruptured liver in another case [171]. Estimates of contaminated oil consumed by two of the dead patients were about 0.3 g and 1.6 g, respectively [171]. One PCB, probably a hexa- or heptachlorobiphenyl from the contaminated oil, was especially concentrated in the tissues. The peaks associated with tetrachlorobiphenyls were very low by comparison, suggesting that total PCBs in the body had been substantially decreased within a year after the end of exposure. The mesenteric fat contained PCBs at 0.9-15.1 ppm, and the liver contained 1.3-10.4 ppm in its fat. PCB concentrations in fatty tissues obtained during 11 control autopsies averaged 2.6 ppm. Of the organs examined (liver, heart, kidney, brain, and skin), the liver and heart usually contained the highest concentrations of PCBs [168,171].

In an additional case, the subcutaneous fat obtained on autopsy of a woman who died in September 1972 (about 2 years after consuming contaminated oil) contained PCBs at 2.9 ppm [168].

Polychlorinated dibenzofurans (PCDFs), mainly penta- and hexachloro compounds, were found in tissues obtained on autopsy of two Yusho patients who died in 1969 and of one who died in 1972 [160]. No chlorinated dibenzofurans were found in tissues obtained on autopsy of two controls, although PCB concentrations of about 1-1.5 ppm were found in adipose tissue and liver fat. The findings from the Yusho patients are summarized in Table III-6.

TABLE III-6

PCBs AND PCDFs (ppm) IN FAT FROM THREE YUSHO PATIENTS AT AUTOPSY

Year of Death	PCBs		PCDFs	
	Adipose	Liver	Adipose	Liver
1969	3.4	4.7	0.03	2.3
1969	8.5	5.6	0.04	1.1
1972	2.1	3.5	0.01	0.3

Adapted from reference 160

The ratio of PCBs to PCDFs in the rice bran oil was about 200, as in the adipose tissues obtained at autopsy. However, in the liver, ratios of 2, 5, and 12 indicate that considerable concentration of PCDFs had occurred.

Information on PCBs [146,147,168,171] and PCDFs [160] in tissues indicates some shifts in concentrations during the 3 years after ingestion of the contaminated oil was discontinued. Masuda et al [168] reported that a year after ingestion stopped, the concentrations of tetrachlorobiphenyl components had decreased and were near those found in persons who had not ingested the contaminated oil. The more highly chlorinated PCB compounds were still retained in the fatty tissue 4 years after ingestion had stopped [168].

Blood from Yusho patients was first examined for PCBs 5 years after ingestion of the contaminated oil ceased. Three distinct GLC patterns were found among blood samples from 49 patients [172-175]. Two patterns (A and B) were peculiar to the Yusho patients, and the third pattern (C) was

similar to that of controls. Patterns A and B were characterized by peaks corresponding to those of certain penta- and hexachlorobiphenyl compounds that were present in the contaminated rice bran oil. Patterns A and B differed, however, as to the relative amounts of these compounds [172,173]. These patterns became diagnostic for Yusho [161]. The average concentrations of PCBs in the blood serum were 9, 4, and 2 ppb for patients with patterns A, B, and C, respectively, and 3 ppb for 27 control subjects [173]. The maximum blood serum PCB concentration found among 72 Yusho patients examined between April 1973 and March 1974 was 26 ppb [174]. Of these patients, 43 had pattern A, 26 had pattern B, and 3 had pattern C.

Similar patterns were reported in 1975 by Abe et al [176] in a 1974 study of 18 female Yusho patients and their 30 children. Concentrations of PCBs in blood samples from mothers ranged from 3 to 33 ppb during 1974; PCBs in samples from their children ranged from 1 to 20 ppb, and in samples from 14 control children, from 1 to 8 ppb. PCB concentrations tended to be higher in the blood samples from children nursed by Yusho mothers. A sample of milk from a Yusho mother was reported in 1974 to contain PCBs with a GLC pattern similar to those in samples of fatty tissue from other Yusho patients [168]. Concentrations of PCBs in the mother's milk were 0.06 ppm on postpartum days 0-2, 0.04 ppm on days 3 and 4, and 0.03 ppm on day 5. The respective concentrations in the milk fat were 4.5, 3.0, and 2.6 ppm.

In addition to the skin and eye conditions manifested by most people who consumed the contaminated rice bran oil [146,151-153,162], there was pigmentation of the nails [146] and of the oral mucosa [154]. A substantial array of clinical and laboratory findings were published on

patients with Yusho [150,152,155,156,177-180], including slight increases in activity of serum alkaline phosphatase, reduced serum iron concentrations [155], changes in the microanatomy of liver cells that were considered indicative of microsomal enzyme stimulation [156], symptomatic and functional changes indicative of neuropathy [150,177], respiratory involvement [170,178], a decreased concentration of bilirubin in the serum [179], and, in many patients, an elevation of the concentration of triglycerides in the serum [155,157,158,175,179-181].

Babies born to women with Yusho, both during and after the period of ingestion of the contaminated rice bran oil, were the subject of several investigations [149,159,176,182,183]. Babies of mothers who had ingested the contaminated oil became known as "black" or "cola" babies because of the abnormal skin pigmentation that tended to persist for several months after their birth [176,182,183]. Infants born up to 5 years after their mothers' last ingestion of contaminated rice oil were still affected to some extent [182]. In one study of four babies, other clinical and anatomical abnormalities (retarded intrauterine growth in three, edematous face and exophthalmic eyes in three, dentition in two, calcification on skull and wide, open sagittal suture of skull in three) were seen at birth [183]. These were not permanent, and postnatal body and mental development appeared normal in these and other Yusho children [160,176,183]. In at least one case, an investigator concluded that a baby had developed Yusho from nursing [182].

The period of ingestion of contaminated rice bran oil was only a few months, but the effects have persisted for several years [160,161,174,175,179,180,184,185]. The skin lesions and hypersecretion

from meibomian glands remained unchanged for long periods in many patients [174,184,185]; their magnitudes in 1974 appeared to be related to blood PCB concentrations [174]. In addition, complaints of generalized fatigue, and symptoms referable to the peripheral nervous system and to the respiratory system became more prominent. In 1974 these complaints and symptoms were established as part of the diagnostic criteria for Yusho [161]. These additional symptoms were not related to the PCB concentrations in the blood [174].

Elevated serum triglyceride concentrations were found to be related to the concentration of PCBs in the blood serum [175], and inversely related to the bilirubin concentrations in the serum [179]. The average serum triglyceride concentrations measured annually in 14 Yusho males from 1969 through 1974 ranged from 159 mg/100 ml in 1969, to 174 mg/100 ml in 1972, to 160 mg/100 ml in 1974 without any significant changes from year to year. In 29 Yusho females, the concentrations initially (1964) averaged 153-161 mg/100 ml, but decreased in 1973 and 1974 to 129 and 111 mg/100 ml, respectively [180].

The Yusho population of about 1,300 persons has been followed closely and records indicate that as of May 1975, 29 of them had died [162]. Deaths have been due to a variety of causes such as accidents, suicides, cardiac problems, and cancers. Malignant neoplasms were found in at least nine cases [161], from which Kuratsune et al [160] concluded that there was a suggestion of excess deaths but that no more could be said because information essential for analysis was not available.

The relevance of the Yusho episode to occupational PCB exposure is compromised because: (1) the oil was ingested; and (2) it contained large

concentrations of dibenzofurans compared with those in the PCBs to which workers generally have been exposed in their occupations. Its relevance is further compromised because the effects observed from daily ingestion of 1-15 mg of PCBs [165,167] were peculiar and excessive compared to those observed in workers exposed by inhalation to PCBs at 1-5 mg/cu m [120,125], notwithstanding that the amounts absorbed may have been similar.

Nevertheless, information obtained from the Yusho episode is relevant to the study of PCB toxicology and occupational exposure. The information establishes that PCBs can be transmitted from mother to fetus, and, in the milk, from mother to child. It also establishes that some PCB compounds are eliminated from the body relatively rapidly, and that others may require years for elimination.

(c) Occupational Exposures

Chloracne was among the earliest reported effects associated with worker exposure to PCBs [125-128]. It was not clear in some early reports that PCBs were contributing to the chloracne because PCBs usually constituted 10-20% of mixtures containing 80-90% chloronaphthalenes, a previously known cause of chloracne [121,122]. An early report that associated chloracne with PCBs in the absence of chloronaphthalenes was that of Jones and Alden [120] in 1936. The manufacturing process was largely an open one and the workers were also exposed to benzene, biphenyl, and other compounds incidental to PCB manufacture. Over the years, cases of chloracne associated with occupational exposure to PCBs have continued to appear [186-196].

Other effects associated with PCBs in early reports included digestive disturbances, eye irritation, liver injury, and impotence

[123,125]. Elkins [130] reported in 1950 that the average concentrations of PCBs in the workroom air of several plants in Massachusetts ranged from 0.1 to 5.8 mg/cu m. Maximum concentrations ranged from 0.2 to 10.5 mg/cu m. No evidence of immediate toxic effects was observed except at PCB concentrations approaching 10 mg/cu m, which the workers found to be unbearably irritating.

Three cases of severe chloracne were described by Puccinelli [186] in 1954. The affected employees worked in a factory that produced capacitors impregnated with Aroclor 1254. The workroom was 24 x 9 x 5 meters. Capacitors were heated to about 100 C in a 3-cu m autoclave to remove moisture, and then impregnated with the Aroclor while in the autoclave. The temperature in the autoclave was reduced about 12 hours later. When the autoclave was opened, the temperature of the Aroclor was 70-80 C. The capacitors were removed and carried to another location for finishing. Originally, one autoclave was used, but eventually eight were in operation, and PCB emissions to the workroom air occurred almost continuously. Concentrations of PCBs in 500-liter samples of air were found to vary from 5.2 mg/cu m in the center of the room, to 6.4 mg/cu m around the finishing operation, to 6.8 mg/cu m near the autoclave during removal of the capacitors. The three chloracne cases were in men, 18-24 years of age. They had worked in the factory for 2-4 years, and developed the first signs of chloracne 4-8 months after their exposures began. Other than chloracne, the men appeared healthy, and all findings, including liver function tests were reported as normal.

Eight other cases of chloracne associated with PCB exposure during the manufacture of radio capacitors were described by Hofmann and Meneghini

[187] in 1962. In the process, PCB vapors were generated by heat. The cases included one man and seven women, 20-37 years of age, who were exposed to PCBs 2.5-4 months before onset of signs of chloracne. The face was involved in six cases; other involved areas varied, but included the arms, neck, upper torso, pubes, buttocks, and thighs. The case of a 21-year-old woman was described in detail. The first signs of chloracne appeared on her face 4 months after she began work, and she was observed by the authors [187] 4 months later. On the face, a dirty brown coloring appeared. A hyperpigmented spot with shaded areas was present on the forehead. Subsequently, her buttocks and pubes became involved. Exposure concentrations were not mentioned.

Severe chloracne was described by Birmingham [188] in 1964 in 13 of 15 workers exposed to an Aroclor which was a mixture of bi- and terphenyls (65% chlorine content). An enamel containing the Aroclor was painted onto glass and then baked in an oven. Faulty ventilation caused contamination by chlorinated hydrocarbon vapors. Exposure concentrations and duration of exposure were not given.

An additional case history published in 1969 involved a 43-year-old man exposed to PCBs in an electrical component factory [189]. He developed chloracne on the forehead, face, arms, and thighs within 3 months after beginning work handling racks of electrical parts that had been dipped in hot PCBs. Exposure concentrations and actual durations of exposure were not stated, but it was reported that the man had put his hands in the mixture without skin protection for a long time, and that his clothes often became impregnated with the PCBs. On examination 8 months after transfer to another job in the same room, papules, comedones, and pustules were

found on his forehead, scalp, face, and arms. Although the man had been removed from direct exposure to PCBs, their odor was present in the man's new work area. It was reported that this was the first case of chloracne in the plant, where more than 100 workers had been engaged in the process for more than 20 years.

A company that used PCBs at two manufacturing facilities provided testimony on employee health in 1975 (In the Matter of General Electric Company, File No. 2833, New York State Department of Environmental Conservation). Examination of records submitted as testimony indicated that exposures were to an askarel [25] containing, by weight, about 60% of Aroclor 1254, 40% trichlorobenzene, and 0.0115-0.135% diepoxide scavengers. From the records submitted, it was not possible to determine the precise numbers of male and female workers. The exact occupations of the workers could not be determined either but a substantial number of "crimpers" was indicated.

The records showed that employees had reported to the dispensary complaining of skin rashes and dermatitis on 49 occasions during the previous 15 years. Only the fingers and hands were involved in 21 complaints, only the arms and hands in 5, and only the face and legs in 1. In 7 other complaints the face, neck, and legs were mentioned in 4, 2, and 1 cases, respectively, in addition to the upper extremities. Associated with the complaints of skin rashes and dermatitis were some complaints of itching of the face (2), neck (1), eyes (1), arms (2), and hands (1). A generalized skin rash was the basis of 14 additional complaints. One worker developed the generalized rash on exposed parts of his body after only 2 days of working with the askarel.

studied [125]. Further details of the animal experiment were reported by Bennett et al [129] in 1938. These investigators [129] found morphologic changes in the livers of two groups of rats exposed at the 0.57-mg/cu m concentration and also at 0.93 mg/cu m for 8 hours/day. These animal experiments reported by Drinker et al [125] and by Bennett et al [129] have continued to be erroneously cited [130,131] even though Drinker [132] reported in 1939 that the "chlorinated biphenyl" was actually a mixture of chlorinated biphenyls and chlorinated terphenyls. Drinker [132] stated that a followup inhalation experiment with chlorinated biphenyls containing 68% chlorine showed them to be of low toxicity and he recommended permissible limits for workroom air of 0.5 mg/cu m for mixtures of chlorinated biphenyls and terphenyls and 10 mg/cu m for chlorinated biphenyls.

The first indication in the literature that PCBs might be embryotoxic or have teratogenic effects was the report by McLaughlin et al [133] in 1963, 5 years prior to the recognition of PCBs as an environmental pollutant. The authors evaluated the toxicity of Aroclor 1242 by injecting it into the yolk sac of fertilized eggs prior to incubation, and then observing the effects on embryonic development. None of the eggs hatched after injection with 25 mg of PCBs/egg; with injection of 10 mg/egg, one chick hatched out of 20 injected eggs, but it died 2 days later. Some of the embryos examined showed beak deformities, edema, and retarded growth.

Effects on Humans

(a) Effects from General Environmental Contamination

In the United States, PCBs are present in ambient air [26,37,38],

The company physicians attributed the rashes to allergic or contact dermatitis caused by exposure to the askarel. Treatment included the use of creams, and temporary or permanent removal from exposure. Of the 49 complaints, 22 were second episodes, and in these cases the workers were removed permanently from exposure to askarels. One female employee who had dermatitis of the fingers was removed from exposure for 12 days. Within 2 days of reexposure she again reacted to the askarel and was permanently removed from such work.

Over the same 15 years, other kinds of complaints were made by the workers on 16 occasions. These complaints included burning sensations of the eyes (7), nose (1), and face (1); dry throat (1); asthmatic bronchitis (3); nausea (1); dizziness (1); and aggravation of acne (1). In most of these cases, the company physicians recommended permanent removal from exposure.

The health status of eight laboratory workers who routinely analyzed dielectric fluids containing PCBs was reported by Levy et al [197] in 1977. The men were 25-49 years of age and had been employed 2.5-18 years. Breathing zone, point source, and general work area air samples were collected on magnesium silicate at 50 ml/minute over the workday on three occasions. The breathing zone samples contained PCBs at 0.014-0.073 mg/cu m. Samples taken near an oven contained 0.042-0.264 mg/cu m, and general room area samples contained PCBs at 0.013-0.15 mg/cu m. The blood PCB concentrations in the workers were 36-286 ppb. The most common complaint of the workers (6 of 8) was dry or sore throat. Other complaints were skin rash (3 of 8), gastrointestinal disturbances (3 of 8), eye irritation and headache (each, 2 of 8). Findings on examination of the eight workers were

skin rash (1), nasal irritation (2), rales (1), and elevated blood pressure (4). No liver, spleen or neurologic abnormalities were found by physical examination. There were no cases of chloracne. Serum alkaline phosphatase, SGOT, SGPT, and total bilirubin, measured in seven subjects, were all within normal limits. In addition, medical records of 40 other exposed employees were examined, revealing two cases of slightly increased SGOT, two elevated serum triglycerides, and one case each of increased serum alkaline phosphatase (SAP) activity, total serum bilirubin, and serum uric acid.

Epidemiologic Studies

An outbreak of dermatitis among workers in a Connecticut chemical plant was described in 1954 by Meigs et al [190]. PCBs had been substituted for molten salt in a heat exchange unit without modification of the system. There were slight, but obvious, vapor leaks under certain conditions, and the concentration of PCBs in the workers' breathing zones was determined to be 0.1 mg/cu m. No employee worked regularly at points of leakage, and the operations, as described, continued for 19 months.

Mild to moderate chloracne on the face, forehead, and ears developed in 7 of 14 exposed workers; the mastoid region of one worker also was affected. The duration of exposure before the initial signs occurred ranged upward from 5 months and averaged 14 months. The average length of exposure was 11 months for those who did not develop chloracne, with one worker showing no signs after 19 months. Liver function tests were performed on the seven workers who had developed chloracne. Clinical tests included direct and total serum bilirubins, 24- and 48-hour cephalin

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flocculations, thymol turbidity, and SAP activity. Findings were normal in six workers, and borderline increases in cephalin flocculation and thymol turbidity were found in the seventh worker with chloracne. Thirteen months later, the thymol turbidity test had improved, but cephalin flocculation had not changed. All cases of chloracne were stated to have cleared up after an unspecified treatment. Control of vapor emissions by welding all joints in the heat exchange unit prevented recurrence [190].

Exposures of workers to PCBs in six industrial plants were discussed by Hasegawa et al [191] in 1972. The concentrations of PCBs found are summarized in Table III-7.

TABLE III-7

RANGE OF PCB CONCENTRATIONS ($\mu\text{g}/\text{cu m}$) IN WORKROOM AIR

Factory	Function	No. Samples	PCB Concentrations	
			Vapors	Particulates
A	PCB manufacture	6	26-163	19-37
B	Capacitor manufacture	3	120-350	20-125
C	Biphenyl recovery	2	13-15	4*
D	Capacitor manufacture	2	350-540	48-6,270**
E	"	3	95-965	73-650

*1 sample

**6,270 due to spillage

Adapted from reference 191

PCBs were manufactured in one plant and used in manufacturing capacitors in four plants (one had discontinued use of PCBs 1 month earlier). Biphenyl, not chlorobiphenyls, was present in the sixth plant [191]. Air samples were collected in two fractions. A fraction associated with particles $>0.1\mu$ was collected on filter paper, and a fraction containing vapors and particles $<0.1\mu$ in diameter was collected in two serially-connected midget impingers containing n-hexane. Samples were collected only from places where high concentrations of PCBs were expected and not from the factory where PCB use had been discontinued.

The vapor concentration exceeded the particulate concentration in all except the sample taken after spillage. Particulate matter was characterized by GLC as containing the same chlorobiphenyl composition as the PCB product used in the plant, whereas the vaporized material contained one less chlorine atom/molecule than the PCB used in the plant.

PCBs were measured in the blood of the employees of six plants, including 99 exposed workers and 32 controls [191]. Concentrations of PCBs in the blood sera of exposed workers averaged 370 ppb, whereas those of the controls averaged 20 ppb. The workers exposed to PCBs in the plant that had discontinued PCB use had serum PCB concentrations of 90 to 730 ppb (average 460 ppb). Based on data from three of the plants, no relationship was found between duration of exposure (from <1 to 20 years) and concentration of PCBs in the blood [191].

Complaints of dermal ailments seemed to be unrelated to the blood PCB concentrations and were considered to be due more to direct contact of the skin with PCBs than to generalized intoxication. The principal dermal findings included brown chromodermatosis of the dorsal joints of the hands

and fingers and of the nail bed, and acneiform exanthema. The latter also involved the jaw, back, and thighs in several cases. The investigators [191] considered that there was a definite effect of PCBs on fat metabolism, as shown by decreases in the concentrations of total, free, and esterified cholesterol in the blood, and by trends in the same direction for neutral fats, total glycerides, phospholipids, and beta-lipoprotein in the blood. There was evidence of mild disturbances of liver function manifested by increased SGOT, SGPT, and SAP activities and decreased activity of serum cholinesterase. These enzyme activity changes were not considered to be clinically significant.

Studies of 38 current and 80 former employees of a capacitor factory in which Kanechlor 500 had been used from 1954 to about 1960 and Kanechlor 300 had been used from about 1960 to 1972, with PCB use having been discontinued in April 1972, were reported by Hara et al in 1973 [192] and again in 1974 [193]. (Presumably, this factory was the one stated by Hasegawa et al [191] to have discontinued use of PCBs.) Current workers included 17 who were engaged in the capacitor immersion process; the remaining 21 workers were engaged in finishing and assembling operations. The study concentrated on the 17 immersion process workers. During exposure to PCBs in March 1972, the concentrations of PCBs in the whole blood of the immersion workers ranged from about 7 to 300 ppb, and were closely related to years of exposure. One year later, blood PCB concentrations had all decreased, but by varying amounts. For example, one of two workers who initially had PCB concentrations in their blood of about 180 ppb had a concentration of <10 ppb 1 year later, while the other one had a concentration >100 ppb. The average PCB blood concentration for the

17 workers decreased to about 75% of the original value. Based on blood samples collected about 6 and 12 months after use of PCBs was discontinued, the blood PCB half-lives for the immersion workers were calculated. It was found that the greater the duration of exposure, the greater the PCB half-life (1 year of exposure, 3 months half-life; 10-15 years of exposure, 30 months half-life). This indicated to the investigators that blood served as a PCB carrier, whereas fat served as a depot tissue [192].

While working with PCBs, many of the total group of employees had dermal complaints (blackheads, 45%; acneiform eruptions, 37%; skin irritations, 13%) [192]. A year after discontinuance of exposure to PCBs, these conditions had improved noticeably and only one or two blackheads remained. No correlation was apparent when concentrations of PCBs and triglycerides in the sera of a large number of workers were compared graphically. The workers were also studied about 18, 24, and 36 months after use of PCBs had been discontinued [193]. During this period, blood PCB concentrations decreased to about 10-20 ppb in all but two workers who had been exposed to PCBs for 9 and 15 years. The skin disturbances were reduced to vestigial markings on a few individuals. Comparisons with the concentrations of triglycerides and PCBs in the sera of these workers indicated that the proportion of workers with significant increases in triglyceride concentrations increased as the concentrations of PCBs increased. Of nine workers with blood PCB concentrations >50 ppb, five had elevated triglyceride concentrations.

Examinations of 13 workers from an electrical capacitor manufacturing plant for clinical manifestations of PCB toxicity were reported by Kitamura et al [194] in 1973. Examinations were performed when the company

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discontinued the use of PCBs in June 1972, and were performed twice subsequently at 3-month intervals. The average length of worker exposure to PCBs had been about 2.5 years. Immediately after discontinuance of PCB use, the average PCB concentration in the blood of workers was 820 ppb, ranging from 320 to 2,100 ppb [194]. The mean concentration fell to 310 ppb after 3 months, and to 200 ppb after 6 months. From these observations, Kitamura et al [194] estimated the biological half-life of the PCBs in the blood immediately following the cessation of exposure to be about 90 days. No consistent correlation could be found between the concentration of PCBs in the blood and the duration of exposure to PCBs. Nail, hair, and gum color and color of the mucous membranes of the oral cavity all were normal. Ten of the workers had varying degrees of skin disorders on different parts of their bodies. The skin disorders included seborrhea adiposa, acne vulgaris, and follicular papules on parts of the body where direct contact with the PCBs normally did not occur. The authors [194] concluded that PCBs probably had been an important factor in the etiology of the skin disorders and that results of blood tests, hepatic function tests, and urinalyses were normal. Serum triglycerides were not determined.

A study by Inoue et al [195] of the health of workers in family-owned silk-thread glossing factories in which PCBs were used was published in 1975. The study was initiated because PCB concentrations exceeding 100 ppb had been found in the blood of a 73-year-old man who had undergone surgery. His family operated a household thread-glossing factory. The family members and the hired helper were studied. Serum concentrations of PCBs resembling Kanechlor 500 ranged from 130 to 520 ppb. There was a close

correlation between the PCB concentration in the blood and the degree of involvement in the glossing work. The head of the household had skin lesions and comedones on the face, back, and ears and had blood PCB concentrations of 190-210 ppb. The rest of the people had practically no skin abnormalities, and other findings (not described) were, in general, considered of minor significance. A study of PCB contamination of the premises and the air of the same factory was reported by Fujiwara et al [33]. At the time the samples were taken, use of PCBs had been discontinued. However, PCBs were found in air at 0.25 mg/cu m, in floor boards at 80-130 ppm, in the dirt under the machinery at 10-900 ppm, and in the dust on steel frame beams at 110-180 ppm. The PCBs were similar to those in Kanechlor 500.

Subsequent to the above study, Inoue et al [195] reported on the PCB concentrations in samples of blood obtained from 54 other similarly employed people. PCB concentrations of over 100 ppb, 50-99 ppb, 10-50 ppb, and 0-9 ppb were found in 2, 5, 19, and 28 persons, respectively. Correlative comparisons with the various functions performed in the factories showed that those workers who had direct contact with the glossing machines, those who maintained and repaired the machines, and those who had over 20 years of work experience had the highest concentrations of PCBs in their blood. Skin abnormalities and other findings in these 54 persons were described as relatively mild. One of the persons studied, a woman in her 10th month of pregnancy, had a serum PCB concentration of 24 ppb. Following birth, the mother and daughter were described as healthy with no evidence of abnormalities. The concentration of PCBs in the mother's milk was found to be 0.25 ppm, and after

consultation, she stopped nursing her baby [195].

In 1974, Sato and Hasegawa [32] discussed their findings on PCB residues in the workers and in the air of pressure-sensitive ("carbonless") copying paper manufacturing plants 2 years after PCB use had been discontinued. A PCB product comparable to Kanechlor 300 was still detected in the workroom air of four of five factories at concentrations ranging from 0.13 to 4.4 $\mu\text{g}/\text{cu m}$; in one factory PCBs comparable to a mixture of Kanechlors 300, 400, and 500 were found at concentrations ranging from 0.15 to 1.2 $\mu\text{g}/\text{cu m}$. Concentrations of PCBs in the blood sera of these workers, as measured by GLC, ranged up to 73 ppb, compared to a maximum of about 20 ppb in controls. The authors [32] concluded that the blood PCB concentrations in the workers were still elevated.

PCB concentrations in the blood of three groups of employees with different PCB exposure histories were presented in 1972 by Karppanen and Kolho [198]. The first group of four men and five women had no known occupational exposure to PCBs. The six women of the second group had been exposed while handling PCBs in an analytical laboratory. The third group of eight men and four women had worked, since 1968, in a plant where Aroclor 1242 was impregnated into capacitors. The authors [198] stated that the workroom air of the capacitor factory met internationally accepted limits (presumably $<1 \text{ mg}/\text{cu m}$), and that protection of the skin had been given special attention. PCB measurements were made by GLC, using electron capture detection. The unexposed group had blood PCB concentrations of 5.6-12 ppb, the analytical laboratory workers had concentrations of 36-63 ppb, and the capacitor plant workers had concentrations of 74-1,900 ppb. Subcutaneous adipose tissue samples from two of the unexposed workers

contained PCBs at 1.5 and 2.3 ppm; PCBs in their blood expressed as concentrations in fat of the blood were 6.6 and 9.9 ppm, respectively. In three capacitor plant workers, adipose tissue samples contained PCBs at 160, 285, and 635 ppm; PCBs in their blood, expressed as concentrations in their blood fat, were 400, 305, and 700 ppm, respectively. All persons examined were in good health. The capacitor plant workers had been under special medical observation but the investigators were unable to detect any biologic effect from the PCBs.

An epidemiologic investigation of 37 refuse workers who were potentially exposed to PCBs emitted from incinerated waste was described by Bumgarner et al [199] in 1973. The control group consisted of 36 workers from a lumber yard. Paired samples of scalp hair and blood were collected. PCB residues in the hair and blood plasma were extracted and analyzed by GLC with electron capture (EC) detection; rough quantitation was by evaluation of five peaks associated with Aroclors 1254 and 1260. The lower limit of detection was 1 ppb. Hematocrit, blood cholesterol, and blood pressure also were determined. PCB residues in the blood plasmas of the controls were detected in four workers and the maximum concentration was 4.2 ppb. Measurable concentrations of PCBs were found in the blood samples of 32 of the 37 refuse workers; the average and maximum concentrations were about 4 and 14 ppb, respectively. The concentrations of PCBs in plasma were not related to duration of exposure, age, or race. PCBs were not detected in hair samples (limit of detection, 1 ppb). Hematocrit, blood cholesterol, and blood pressure values did not change at different PCB concentrations.

A survey of the health of 34 workers exposed to Aroclor 1242 during manufacture of capacitors was discussed by Ouw et al [196] in 1976. The Aroclor was an electrical-grade material that contained "no impurities." Breathing zone samples were collected in impingers containing isopropanol. It is not clear if all samples were collected from the breathing zones. Nineteen workers were assigned to fill capacitors with Aroclor 1242 heated to 70 C. These workers were exposed to PCBs at 1.08-1.44 mg/cu m. The other 15 workers, located in a different room, were assigned to assemble Aroclor-dipped capacitor components. These workers were exposed to PCBs at 0.32 mg/cu m. None of the 34 workers used protective clothing.

PCBs in the blood were separated by GLC and identified by their retention times relative to aldrin. PCBs were not detected in the blood of 30 control subjects. For the two groups of PCB-exposed workers, averages of measurable blood PCB concentrations are presented in Table III-8.

TABLE III-8

AVERAGE OF DETECTABLE BLOOD PCB CONCENTRATIONS (ppb)
OF TWO GROUPS OF WORKERS

Exposure Group	No. Workers	PCB Retention Time Relative to Aldrin			
		0.69	1.31	1.47	1.96
Fillers	19	602(19)*	314(17)	391(13)	475(4)
Assemblers	15	140(14)	100(14)	899(5)	(0)

*Numbers in parentheses are the numbers of workers in whom more than a trace of the PCB peak was detected.

Adapted from reference 196

Distribution of PCBs in the blood of workers exposed while filling the capacitors differed from that of workers who assembled the components. The higher boiling components were present more frequently and to a greater extent in the fillers.

Twelve of the workers (5 of 19, and 7 of 15) complained of mild burning and irritation of the face, eyes, and skin, and 5 of these had eczematous rashes on the hands and legs. One filler had chloracne. Although individual abnormalities were found in SGPT, SAP, and bilirubin, the average values for the exposed workers were within normal limits. Bromsulphothalein retention tests were found to be elevated in four of the seven fillers whose blood PCB concentrations were >500 ppb. The investigators [196] reported no evidence of significant adverse responses to PCB exposure in the workers with blood PCB concentrations below 200 ppb.

Subsequently, "more efficient" exhaust ventilation was installed and the workers were advised to wear "suitable impervious gloves" [196]. Air measurements, made after the ventilation change, indicated that the fillers were being exposed to PCBs at 0.18-0.75 mg/cu m and the assemblers at 0.08 mg/cu m. These were substantial reductions. However, blood PCB concentrations that were found in 15 workers reexamined 2 months after the ventilation change did not show any substantial reductions. The investigators [196] speculated that this might have been because the workers did not strictly follow the recommendation to wear protective clothing.

Based on a search of chart records, Bahn (HA Sinclair, written communication, June 1976) reported a preliminary study of the incidence of cancer in a group of 51 research and development employees and 41 refinery

plant employees at a New Jersey petrochemical facility who were considered likely to have been exposed to Aroclor 1254 for various periods between 1949 and 1957. The eight cancers observed in the study population through December 31, 1975 were not significantly more than would be expected (5.7) in a similar sample of the US population [200]. However of the eight cancers, the three melanomas and the two cancers of the pancreas were significantly different from calculated expectations. Some findings of this preliminary investigation were described in a letter from Bahn et al [201] to the editor of the New England Journal of Medicine.

In this preliminary study, PCB exposure histories were based on recollections of two company employees. Exposures to other chemicals could not be ascertained. The expected cancer rates were based on US population data rather than on a rate for the locality of the petrochemical facility. To correct these deficiencies in the preliminary study, a more intensive investigation is being conducted (BN Kightlinger, written communication, November 1976). A substantial change has occurred in the cohort since release of the preliminary report by Bahn and her coworkers, and it seems likely that the findings on this new cohort will differ significantly from those of the preliminary study. The final report is not yet available.

In a study of current and former employees engaged in the manufacture of PCBs, no cases of malignant melanoma or pancreatic cancer were found from a review of the case histories of more than 300 employees (G Roush, written communication, September 1976). Seven cases of lung cancer were found from the death certificates of 50 former employees compared to an expected number of 2.7. The data are preliminary and were not corrected for age or smoking habits. The final report is not yet available.

Animal Toxicity

Although there have been a few reports of dermal and inhalation experiments with animals, most of the information on animal toxicity has involved ingestion of PCBs in the diet or by intubation. Several animal experiments have involved oral administration of PCBs for the lifetime of the animal. These studies have demonstrated chronic changes in the microscopic anatomy of the liver and other organs, effects on reproduction, embryonic and fetal toxicity, effects on offspring from nursing, and carcinogenic and teratogenic responses.

(a) Inhalation and Dermal Application Studies of PCB Mixtures

Absorption and distribution of inhaled PCBs were studied by Bente et al. [97] in 1972. Groups of 4-6 male Wistar rats were exposed to aerosols of a commercial PCB mixture containing 42% chlorine, Pydraul A 200, commonly used in hydraulic fluids. Absorption and distribution of the PCBs were studied through the measurement of PCB concentrations in liver, brain, and adipose tissue. The aerosols were produced in an aerosol generator at 180 C. The aerosols were cooled, the larger particles were separated out, and the airborne PCBs were introduced into a chamber at a concentration of 30.4 ± 3.4 g/cu m. Groups of the rats were exposed for varying periods up to 2 hours. It was found that 15 minutes of exposure was sufficient to attain more than 50% of the PCB concentration of 69.7 μ g/g liver wet weight that could be attained with 2 hours of exposure. Consequently, the investigators used an exposure time of 30 minutes to study distribution of PCBs to the tissues.

Immediately after 30 minutes of exposure, PCB concentrations were maximal, at about 52 μ g/g liver tissue, whereas they were at low

concentrations in the other tissues at 14 $\mu\text{g/g}$ in adipose tissue, and 9 $\mu\text{g/g}$ in brain tissue. After 24 hours the PCB level in the brain attained a maximum value of about 18 $\mu\text{g/g}$ and within 36 hours the PCB concentration in the adipose tissue attained a maximum of about 250 $\mu\text{g/g}$. By 48 hours the concentrations of PCBs in the liver were reduced to about 3 $\mu\text{g/g}$ and in the brain to about 5 $\mu\text{g/g}$, whereas the adipose tissue concentrations remained above 200 $\mu\text{g/g}$.

Experiments were reported by Rozanova [202] in 1943 in which rats were exposed to a technical mixture of "tetrachlorodiphenyl" and "pentachlorodiphenyl." The mixture, known as Solvol, was a transparent, colorless, oily, very viscous liquid used for filling capacitors. The "tetrachlorodiphenyl" component of the mixture had a distillation range of 220 to 245 C and the "pentachlorodiphenyl" component had a distillation range of 242 to 260 C. The animals were exposed in a 22-liter chamber through which air was drawn continually at a rate of 1-1.5 liters/minute, after first passing through a glass gooseneck containing the liquid PCBs. Air samples were taken from the chamber from time to time to determine the PCB concentrations. The analytical method was not reported.

Four rats exposed for 3 hours at about 10 mg/liter became uncoordinated and comatose and died within a day [202]. Autopsy findings included liver necrosis and fatty degeneration, cloudy swelling of the epithelial cells of the renal tubules, congestion in the heart and spleen, and necrotic signs in the spleen. Three rats were exposed repeatedly to vapors of Solvol at 0.5 mg/liter. One rat died after eight exposures, and the other two were killed after 11 exposures. Five other rats were repeatedly exposed at 0.25 mg/liter; one was killed after 16 exposures, and

the others, which appeared to be in satisfactory condition, were killed after 69 exposures. In these chronically exposed rats, gross and microscopic findings were similar to, but less marked than, those found in the acutely exposed animals. In addition, hyperplasia of the Kupffer cells was found in the liver.

Traen et al [203] exposed groups of animals each comprised of 10 rats, 10 mice, 6 guinea pigs, 4 rabbits, and a cat to Aroclor 1242 or Aroclor 1254 vapors 7 hours/day, 5 days/week for up to 31 weeks. Aroclor 1242 exposures at concentrations of 8.6 $\mu\text{g/liter}$ (0.83 ppm) for 3 weeks, 6.83 $\mu\text{g/liter}$ (0.66 ppm) for 17 weeks, or 1.9 $\mu\text{g/liter}$ (0.18 ppm) for 31 weeks. Exposures to Aroclor 1254 were at 1.5 $\mu\text{g/liter}$ (0.11 ppm) for 31 weeks or at 5.40 $\mu\text{g/liter}$ (0.41 ppm) for 17 weeks. No consistent changes in mortality, growth, pathology, organ size, liver function, or hematologic parameters were found in animals exposed to Aroclor 1242. The animals exposed to Aroclor 1254 vapors showed no changes in growth or mortality but microscopic evidence of apparently reversible hepatic cellular injury was found in all species except the cat at both exposure levels. Enlarged livers were found in the animals exposed at 5.40 $\mu\text{g/liter}$. An appreciable incidence of pneumonia was found among the exposed and control animals, a fact which could have confounded some of the results, but it is important to note that liver changes, including fatty degeneration, were found in exposed animals that were free of pneumonia.

Inhalation experiments with the commercial PCB product "Decachlorodiphenyl" were reported by Berczy et al [98,99] in 1974. The oral toxicity of this PCB product was investigated by Hunter et al [204], who administered it in the diet to Sprague-Dawley rats at 1,000, 2,000,

5,000, and 10,000 ppm for 4 weeks. All animals fed Decachlorodiphenyl gained more weight than the controls and had greater liver to body weight ratios. Other effects observed at 10,000 ppm included increased spleen, thyroid, and kidney weights relative to body weights, reduced hemoglobin concentrations, and in males reduced rbc counts and hematocrits.

In one inhalation experiment [98], five male and five female rats were exposed for 6 hours to particles of the PCB product at an average concentration of 2.54 mg/liter. Seventy-eight percent of the particles were in the range of 1-5 μ m in diameter, 17% in the range of 5-15 μ m, and the remaining 5% were >15 μ m. During exposure there were repeated episodes of blinking and sneezing. Signs of irritation disappeared after cessation of exposure. During the subsequent 14-day observation period, food and water consumption and growth of the rats were considered by the authors to have been similar to those of the controls. No gross pathological changes were seen when the rats were killed 14 days after removal from exposure [98].

Subsequently [99], three groups of rats, each consisting of 8 males and 8 females, were exposed 6 hours/day, 5 days/week for 4 weeks at average concentrations of 4, 80, and 777 μ g/liter. A similar group of rats was used as a control. In this experiment, where 85-90% of the particles were in the 1-5 μ m range and 1-3% were >15 μ m, no signs of irritation were seen during the exposures at the lower concentrations and growth rates were normal compared to controls. At the highest concentrations, frequent blinking and sneezing were noted during the exposures, and the growth rate of the males was slightly retarded (final body weights of 395 g vs 435 g for controls). The liver weights, relative to body weight, were increased

in males exposed at the highest concentration, and in females exposed at the medium and high concentrations. Microscopic findings in the livers of the rats exposed at the high concentration included occasional focal aggregations of mononuclear cells with either parenchymal or periportal distribution, and minimal degrees of periportal hepatocytic vacuolation, and decreased centrilobular or periportal glycogen. These findings were not considered by the authors [99] to be of toxicologic significance. A statistically significant decrease in packed cell and mean cell volumes was found in male rats exposed at the high concentration. In this group there was also a low white cell count due to a decrease in the number of lymphocytes, and increased thrombocyte activity. Blood glucose, SGOT, and serum sodium concentrations were decreased.

Von Wedal et al [205] described in 1942 the results of an experiment performed to determine the systemic effects of exposure of mice, guinea pigs, and rabbits, by inhalation, ingestion, and dermal application to an unspecified Aroclor. Concentrations and durations of exposure were not specified for the inhalation and ingestion experiments. However, 0.5, 1.0, or 1.5 ml of solutions containing 0.5 g Aroclor/ml were used for the dermal applications. Within 5 days after the dermal applications, small papules and blisters formed on the exposed skin areas and the external epidermal layers became desquamated. In addition, subacute yellow atrophy of the liver with some fatty infiltration was observed. Similar liver lesions were produced in the inhalation experiment.

In 1944, Miller [206] administered Aroclor 1242 to rats, rabbits, and guinea pigs by subcutaneous (sc) injection, by oral intubation, and by dermal and corneal application. The PCB doses ranged from single doses of

69 mg to small drops (approximately 17 mg) applied daily to the cornea of rats for 25 days, to 1,380 mg injected daily into rabbits for 10 days. Fatty degeneration and atrophy of the centrilobular cells of the liver were the characteristic signs of toxicity. The greatest amounts of liver damage were seen in guinea pigs, less was seen in rabbits, and the least amount in rats, regardless of the dose, duration of exposure, or route of administration. Necrotic lesions were also seen in the skin of animals that received sc injections; signs of dermal irritation were seen after applications to the skin. The conjunctival tissue presented no gross changes when examined under magnification in the living animals. Since the pathologic changes in internal organs were similar regardless of method of administration, this experiment indirectly demonstrated that PCBs could be absorbed through the skin and the eye.

The effects of Solvol applied to the ears of rabbits were reported by Paribok [207] in 1954. Solvol was applied for 6 hours daily in doses of 0.7 to 3.76 g. A single application caused edema and inflammation of the ear, and one rabbit died 7 days after the application. With multiple doses, the animals died after 6-17 days. The dead animals, including the one that died after the single application, had fatty degeneration of the livers.

Vos and Beams [208] reported in 1971 on the dermal toxicity of PCBs in adult female New Zealand rabbits. Three commercial preparations of PCBs were used: Clophen A60, Phenoclor DP6, and Aroclor 1260. Twenty-seven 1-ml (118 mg) applications of each of these products (in isopropanol), 5 times/week over 38 days, to the clipped and shaved backs of the rabbits resulted in various manifestations of toxicity.

In general, the toxic signs were most pronounced in the Clophen-treated animals and least pronounced with Aroclor 1260. Dermal findings included thickening of the skin due to hyperplasia and hyperkeratosis of the epidermal epithelium, and dilation and plugging of hair follicles with keratinous material. Microscopic study of liver sections showed a considerable diversity of lesions, including centrilobular degeneration, focal hydropic degeneration, focal necrosis, atrophy of centrilobular parenchymal cells, cytoplasmic hyaline degeneration, pigmentation of Kupffer cells, and, to a lesser extent, pigmentation of parenchymal cells. Renal damage was found in all PCB-treated animals. The most common findings were hydropic degeneration of the convoluted tubules, with nuclear pyknosis, and bursting and lysis of the tubular epithelial cells [208]. Dilation of the renal tubules, filled with casts of necrotic epithelial cells, was found in half the rabbits. These findings indicate that the dermal application of PCB mixtures causes systemic lesions of the liver and kidneys besides the direct effect on the skin. However, in other studies [19,21,23], it was determined that Clophen A60, Phenoclor DP6, and Aroclors 1248 and 1254 were contaminated, to varying degrees [21], with highly toxic tetra- and pentachlorodibenzofurans.

(b) General Effects of Oral Administration of PCB Mixtures

Single-dose oral LD50's of several PCBs reported in rats (JW Cook, written communication, June 1970) generally indicated that as the degree of chlorination increased, the acute toxicity decreased. The more highly chlorinated products (Aroclors 1248-1268) were of approximately equal toxicity (LD50's of about 10 g/kg), whereas the LD50's of the less highly chlorinated products (Aroclors 1221-1242) ranged from about 4 to 9 g/kg.

The minimum lethal doses of these PCBs applied to the skin of rabbits were generally in the range of 1-2 g except for 1221 which was in the range of 2-3 g and 1268 which was >2.5 g.

The immunosuppressive activity of Aroclor 1260 was described in 1972 by Vos and de Roij [209] who fed three groups of 12 4-week-old female albino guinea pigs the PCB at 0, 10, or 50 ppm in their diets for 8 weeks. Aroclor 1260 was analyzed and found to be free of contamination with chlorinated dibenzofurans, although it appeared to contain a minor acnegenic impurity. In each group, six animals received sc injections of aluminum phosphate-adsorbed tetanus toxoid to stimulate the lymphoid system (antitoxin production). The other six animals in each group served as positive or negative controls. Cellulose acetate electrophoresis was used to determine serum proteins, including gamma-globulins. The gamma-globulin-containing cells in the popliteal lymph nodes were significantly reduced in the stimulated animals fed PCBs. Serum gamma-globulin levels were significantly decreased in the guinea pigs stimulated with tetanus toxoid and fed 10 ppm of Aroclor 1260 in their diet. Increased serum alpha-globulin levels were found in the stimulated guinea pigs fed either 10 or 50 ppm of the PCB, and significantly increased concentrations of albumin were found in the sera of both the stimulated and the unstimulated guinea pigs fed the PCB at 10 ppm. Also, both the absolute and relative weights of the cervical lymph nodes in the unstimulated group fed 10 ppm of Aroclor 1260 were significantly reduced whereas those of the mesenteric lymph nodes in the stimulated guinea pigs fed 10 and 50 ppm of PCB were significantly increased. These findings indicate that some immunosuppressive effect was produced by the feeding of PCBs. However, the

decreases of the gamma-globulin levels were not found to be dose-related. No evidence of any PCB-induced change was observed in microscopically examined stained sections of liver, kidneys, adrenals, and skin.

Vos and Van Driel-Grootenhuys [210] reported their studies of the effects of PCBs on the humoral and cell-mediated immunities of guinea pigs in 1972. Three experiments were performed with different protocols. In the first experiment, the authors investigated the humoral immune response of guinea pigs fed 0, 10, 50, or 250 ppm of Clophen A60 in their diets and stimulated with a single sc injection of tetanus toxoid 3 weeks after the feeding regimen began. Suppression of humoral immunity was observed at the 50-ppm level. Microscopic examination of the livers revealed centrilobular degeneration, cellular atrophy, cellular necrosis, and nuclear enlargement. At the 250-ppm level, no antitoxin production was observed.

The diets of guinea pigs in a second experiment [210] contained 0, 10, or 50 ppm of Clophen A60 or 50 ppm of Aroclor 1260. Primary and secondary antigenic stimulations with tetanus toxoid were given after 3 and 5 weeks. The experiment lasted 6 weeks. Suppression of the humoral immune response was observed in groups fed 50 ppm of either PCB product. Decreases in the weights of the thymuses and increases in liver weights were observed at the 50-ppm Clophen A60 level and, to a lesser degree, at the 50-ppm Aroclor 1260 level. The residual liver concentrations of PCBs increased as the dose level and the duration of exposure increased.

In their third experiment, Vos and Van Driel-Grootenhuys [210] fed 30 guinea pigs diets containing Clophen A60 at 0, 50, or 250 ppm. After 3 weeks, the animals were challenged with 0.05 ml of Freund's complete adjuvant followed in 47 days by an injection of 0.1 ml of avian tuberculin

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antigen. The animals were killed 2 days later. All animals of the 250-ppm group died during the experiment, exhibiting retarded growth, atrophy and depletion of the lymphoid system, and liver damage. Significantly decreased thymus weights and increased liver weights also were observed, and total white blood cell counts were reduced significantly.

Bruckner et al [211] administered Aroclor 1242 to rats by oral intubation to determine its acute and subacute effects. Two groups of six rats each were given single doses of either 2.5 or 6.0 g/kg of Aroclor 1242. The initial effects observed at both dosages were the same for the first 4 hours, ie, diarrhea, decreased spontaneous activity and muscle tone, decreased response to pain stimuli and mild chromodacryorrhea. However, during the next 24 hours the group receiving 6.0 g/kg had profuse diarrhea, adipsia, oliguria, anorexia, erythema of the limbs, lack of response to pain stimuli, and general weakness. Eventually, ataxia, coma, and death followed. The condition of the rats receiving the lower dosage gradually improved after the first 24 hours and was normal at the end of 72 hours.

Another group of rats [211] that received single oral doses of 4 g Aroclor 1242/kg showed weight loss, elevated packed red cell volumes, increased serum polymorphonuclear leukocytes, crenated red blood cells, and increased SGOT activities. All organs appeared normal except the livers and kidneys. The livers exhibited foci of sudanophilic vacuolation. The kidneys showed widely scattered foci of vacuolated tubular epithelial cells.

In the subacute studies conducted by Bruckner et al [211], six rats were given 100 mg of Aroclor 1242/kg orally every other day for 3 weeks;

three control rats received 100 mg/kg of peanut oil on the same schedule. Changes observed in the treated rats included increased liver weights, decreased packed red blood cell volumes, increased SGOT activities and marked increases in liver microsomal hydroxylating and N-demethylating enzyme activities. Microscopic examinations of the livers and kidneys revealed greater increases in generalized lipid vacuoles than had been found with the acute doses. When single ip doses of 100 mg Aroclor 1242/kg were given to rats, increased N-demethylase and aniline hydroxylase activities were observed after only 24 hours [211].

The effects of lower dietary levels of Aroclor 1242 on rats were reported by Bruckner et al [212], who fed it to groups of six male Sprague-Dawley rats at concentrations of 0, 5, or 25 ppm for 2, 4, or 6 months. Small reductions in hematocrit and hemoglobin levels similar to those found in other studies by Bruckner et al [211,213] were seen. Urinary excretion of coproporphyrin was significantly increased and dose-dependent increases in liver microsomal hydroxylase activity were measured at the time of each sampling. Similar dose-dependent relationships were found in other experiments [213,214]. Proliferation of the hepatic endoplasmic reticulum was seen after 2 months of ingesting a diet containing 25 ppm of Aroclor 1242; after 4-6 months of such ingestion, lipid vacuolization of the liver was evident.

In 1974, Bruckner et al [213] reported reduced weight gain, hepatic and renal damage, and an increase in urinary coproporphyrin excretion in rats injected ip with a total of 1.6 g/kg of Aroclor 1242 during a 10-week period. The hydroxylating and N-demethylating activities of the liver were significantly elevated 24 hours after a single ip injection of 100 mg/kg of

Aroclor 1242, with hydroxylating activity showing the greater increase. Cytochromes P-450 and b5 and NADPH-cytochrome reductase activities of the liver all were significantly increased 3 days after dosing. A single dose of 50 mg/kg gave similar but less marked effects, whereas 25 mg/kg produced significant increases in only hydroxylating and N-demethylating activities.

Kimbrough et al [215] described in 1972 some effects of chlorobiphenyl mixtures on the livers of rats. Groups of 3- to 4-week-old male and female Sherman strain rats were given Aroclors 1254 and 1260 at 0, 20, 100, 500, and 1,000 ppm in their diets. Each group consisted of 10 males and 10 females. Food consumption was measured periodically. The animals were fed the PCBs for 8 months.

One female fed 100 ppm of Aroclor 1260 died after 6 months and two females fed 500 ppm died after 1 and 2 months. Eight females fed the 1,000 ppm diet died in 2-6 months. The rats fed 500 and 1,000 ppm gained less weight than did the controls. At autopsy, livers of the male rats fed Aroclor 1260 weighed significantly more than did livers of control male rats. Livers of the females were larger than normal but the weight differences were not statistically significant, although at 500 ppm the fractions of body weight represented by the livers increased significantly as a result of the reduced body weight gain. Microscopic findings in the livers included hepatocytic hypertrophy, inclusions in the cytoplasm, brown pigment in the Kupffer cells, lipid accumulations, and, at the higher dietary levels, adenofibrosis. The nodular grayish-white areas that represented extensive foci of adenofibrosis consisted of fibroblasts and collagen that surrounded rosettes of epithelial cells [215].

Aroclor 1254 produced similar results [215]. One female and two male rats died at 500 ppm, but none died at the lower dietary levels, and the rats fed 500 ppm gained less weight than did controls. Ultrastructural changes in the livers of exposed animals consisted of proliferation of the smooth endoplasmic reticulum (SER) and atypical mitochondria. Similar changes have been observed in other experiments with PCBs [131,212,216-218]. A major difference between the effects of the two products was the much higher incidence of hepatic adenofibrosis at a lower dietary level of Aroclor 1254 (100 ppm). In general, the effects of Aroclor 1254 on the liver were more pronounced than those of Aroclor 1260.

In 1973, Kimbrough et al [219] reported the results of a study conducted to determine whether morphologic changes produced in the liver would regress after ingestion of PCBs was stopped. Fifty male SPF Sherman strain rats were given Aroclor 1254 at 500 ppm in their diets for 6 months, and then were returned to normal diets. Groups of five rats were killed 0, 1, 2, 3, 4, 6, 8, and 10 months after ingestion of PCBs had been discontinued. The livers and adipose tissues of the 10-month group were analyzed for PCBs. Control animals were used in all evaluations and were fed only laboratory chow.

The livers of exposed animals killed when exposure to Aroclor 1254 was discontinued were enlarged and most of the 40 livers studied microscopically showed enlarged hepatocytes, increased lipid contents, and adenofibrosis. A brown pigment was seen in the Kupffer cells and in other macrophages of 15 livers. Small adenofibrotic lesions consisting of glandular epithelial cells that formed ducts surrounded by slight amounts of fibrotic tissue were seen; larger lesions had more extensive fibrosis

and contained collagen. Similar findings had been reported earlier by Kimbrough et al [215] and both in the areas of adenofibrosis and in otherwise normal hepatic tissue, Kimbrough [220] later reported finding small clusters of glandular type cells, resembling those of pancreatic tissue in general appearance and staining characteristics, in 15 of 36 rat livers with adenofibrosis. The cells stained red with the stain used for esterase, and developed a blue granular appearance with the stain used for protein bound tryptophan. These staining reactions were suggestive of those of salivary gland tissue to the author. The cells may have been derived from either ductal or vascular epithelium, but there is no evidence to substantiate either suggestion [220].

Signs of regression of the adenofibrotic lesions were not noted except for the disappearances of epithelial cells from the centers of the lesions [219]. Liver weights did regress to normal after 10 months without PCB exposure, but the lipid accumulation and the hypertrophy of the hepatic cells remained unchanged. Analysis of adipose tissues from the final group of rats killed showed that the PCB levels ranged from 924 to 1688 ppm (mean, 1192 ppm). Liver PCB levels ranged from 17.3 ppm to 26.2 ppm (mean, 22.7 ppm). The PCB concentrations in the adipose tissue and livers of the control animals were less than 1.0 ppm. The authors [219] were unable to decide whether contamination of Aroclor 1254 with dibenzofuran was responsible for the observed liver lesions [219].

Kimbrough and Linder [221] reported in 1974 the results of a PCB-feeding experiment which they undertook to induce adenofibrotic lesions in the livers of BALB/cJ inbred male mice, ie, lesions similar to those previously observed in rats fed Aroclors 1254 and 1260. Two hundred mice,

5-6 weeks old, were distributed randomly into 4 groups of 50 each. Two groups were fed a ground diet containing 300 ppm of Aroclor 1254. At the end of 6 months, one of these exposed groups was placed on a PCB-free diet while the other exposed group continued on the test diet for another 5 months. The other two groups served as controls and were fed the plain ground laboratory diet for the entire 11 months. The average PCB intake was 49.8 mg/kg/day in the mice fed the PCB diet for the entire 11-month period.

Livers of 45 of the 58 surviving control mice were found to be normal. The other 13 had focal round-cell infiltrates and sometimes small areas of necrosis and fibrosis. Skin abscesses, usually near the groin, were identified in all 13 control mice with hepatic round-cell infiltrates. These skin lesions were thought to be abscesses of the preputial glands. In comparison, 10 hepatomas were identified in 9 of the 22 survivors in the group fed the PCB diet for 11 months. These tumors consisted of well-differentiated hepatocytes, relatively uniform in size but usually smaller than the surrounding liver cells. They were well circumscribed and surrounded by compressed hepatic parenchymal cells or strands of fibrous tissue. In the larger tumors, there were areas in which the sinuses were dilated and filled with a pink-staining amorphous material. No metastases were seen on gross inspection of the organs, although no detailed screening, such as serial sectioning of the lungs, was undertaken. Only one small hepatoma, composed of well-differentiated hepatocytes, was identified among the 24 survivors fed the PCB diet for only 6 months. The authors [221] noted that the mouse strain used in this study rarely develops hepatomas spontaneously.

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Adenofibrosis was identified in the livers of the mice subjected to the 11-month PCB diet. These lesions, according to the authors [221], may or may not be precursors of malignant lesions. They were seen in several areas of each liver as fibrosis and as glandular formations of proliferated epithelial cells replacing parenchymal cells. They formed ducts which produced mucus and which were surrounded by connective tissue of varying abundance.

Allen and Abrahamson [216] reported on morphologic and biochemical changes in the livers of rats given Aroclors 1248, 1254, and 1260 at 1,000 ppm in their diets for 6 weeks. A control group was fed unsupplemented chow. Each group contained 24 rats. Four rats were killed after 1,3,7,14,21, 28, and 42 days of exposure. White blood cells, hemoglobin (Hb), hematocrit (Hct), differential white cell count, total serum proteins, and blood urea nitrogen (BUN) were measured at each interval. Selected tissues were prepared for microscopic examination and the livers were homogenized and analyzed for cytoplasmic protein, DNA, and RNA. Liver microsomes were examined for aryl hydrocarbon hydroxylase, nitroreductase, N-demethylase, and nitrophenylacetate hydroxylase activities, and for cholesterol content.

All of the PCB-dosed rats failed to gain weight. The most severe effects were noted with Aroclor 1248, followed by Aroclors 1254 and 1262. All blood samples showed increases in Hb and Hct, with no changes in the white blood cell counts. Neutrophils were increased in the sera of all treatment groups. There were no changes in BUN or in total serum protein levels. Organ weights in all of the experimental rats constituted higher percentages of total body weights than in controls; the livers showed four-

fold increases in weight in all PCB-dosed groups. The increased liver weights were discernible after only 1 day of exposure. Liver hypertrophy was attributed to proliferation of SER, development of large concentric arrays of membranes, and increases in lipid droplets within the cytoplasm of the affected cells. Aroclor 1248 was the most, and 1262 the least, toxic PCB product as judged by changes in liver histology. Liver homogenates contained increased concentrations of protein and RNA, and decreased concentrations of DNA. These changes were seen within 2 weeks after initiation of feeding Aroclors 1248 and 1254; the protein and nucleic acid concentrations then either leveled off or decreased after 4-6 weeks. Aroclor 1262, however, did not induce these effects until 4 weeks after the beginning of feeding; the initial changes were followed by reversals [216].

Liver microsomal fractions had increased protein and phospholipid concentrations. These changes occurred earlier in the rats fed Aroclor 1248 and 1254 than in the Aroclor 1262-fed animals. Microsomal nitroreductase activity, expressed on the basis of microsomal protein, was variable in the animals fed Aroclors 1248 and 1254; however, all animals fed Aroclor 1262 had progressive increases in nitroreductase activity. N-demethylase activity increased early in the experimental period and increased progressively in all treatment groups as the exposures continued. Aryl hydrocarbon hydroxylase, glucose-6-phosphatase, and other esterase activities increased initially, followed by continuous declines in activity in the groups fed Aroclors 1248 and 1254. The rats fed Aroclor 1262 had similar, but less marked, changes. When enzyme activities were expressed as activity per total liver, all showed marked increases. After 6 weeks, other degenerative changes in the liver occurred, such as dissolution of

the concentric arrays of membranes, vesiculation of the endoplasmic reticulum, and accumulation within the cytoplasm of lipid droplets that had developed during the hypertrophic phase of the intoxication [216].

Allen et al [222] administered PCBs (Aroclor 1248) and polychlorinated terphenyls (Aroclor 5460) to rhesus monkeys. Sixteen male monkeys were distributed into three groups. Group 1 consisted of six animals and was fed a basal diet supplemented with 300 ppm of Aroclor 1248. Group 2 consisted of six animals fed a basal diet containing 5,000 ppm of Aroclor 5460. The remaining four monkeys constituted the control group and were fed the standard colony diet. Each animal had access to 400 g of diet daily. The physical status of the animals was evaluated daily and "complete" blood studies were performed biweekly. Approximately 10 g of liver tissue were removed from each animal during the 6th week (via laparotomy) and during the 12th week (at necropsy) for biochemical and microscopic evaluation.

Animals fed Aroclor 1248 lost an average of 26% of body weight; those receiving Aroclor 5460 lost an average of 19% of body weight. Gross changes seen in the animals fed Aroclor 1248 included loss of hair from head, neck, and back, puffy faces, edematous lips, and swollen eyelids with purulent exudates around the eyes. These changes were seen within 1 month; similar, but less marked changes were seen in the animals fed Aroclor 5460 [222].

Hematologic changes developed gradually. After 3 months, hemoglobins had decreased by about 2 g/100 ml, and hematocrits had diminished from about 40% to 33%. Total white blood cell counts did not change; however,

there was a shift to the left in the differential count. Total serum proteins decreased by about 1.5-2 g/100 ml, and there was a gradual shift in the albumin/globulin ratio of the serum protein. No changes were seen in SGOT or BUN. Both experimental groups had similar patterns of changes [222].

At necropsy, both groups of animals showed extensive alopecia, acneiform lesions of the skin, subcutaneous edema, liver hypertrophy with fatty infiltration, and gastric mucosal hypertrophy and hyperplasia. Liver hypertrophy was attributed mainly to proliferation of the hepatocytic SER. Gastric hypertrophy was characterized by thickened gastric mucosa, numerous large cystic areas filled with mucin, and hyperplasia. Ulceration was seen, as was invasion of the underlying mucosa by glandular-type epithelial cells [222].

The authors [222] noted that, biochemically, the decreases observed in the DNA concentrations of the livers of both experimental groups reflected the hypertrophic cells observed microscopically, and the increases in protein and RNA were said to be compatible with the proliferated SER. Levels of microsomal protein per gram of protein were not markedly altered, but decreases in the specific activities of esterase, aniline hydrolase, nitroreductase, and glucose-6-phosphatase became apparent within 6 weeks, and persisted. N-demethylase activity was increased at each examination.

The results of a toxicity study conducted on four young male rhesus monkeys fed Aroclor 1242 at concentrations of 3, 10, 30, or 100 ppm were reported by Ball [223], McNulty [94], and in a communication written in

March 1977 by WP McNulty. All four monkeys on these diets died within 9 months. The monkeys had facial swelling, red and swollen eyelids, conversion of all secretory-type cells of the stomach to mucous cells, growth of mucous glands into the muscular walls of the stomach, multiple ulcers in the stomach, atrophy of the thymus gland, and either disappearance of sebaceous glands or conversion of these glands to keratin cysts, particularly in the eyelids.

Allen et al [104] and Allen and Norback [224] found gastric hypertrophy and hyperplasia and focal ulceration of the stomach lining in adult male rhesus monkeys fed single doses of 1.5 or 3.0 g of Aroclor 1248.

(c) Studies Involving Individual PCB Isomers

In 1972, Vos and Notenboom-Ram [225] discussed the comparative toxicities of dermally applied 120-mg doses of 2,2',4,4',5,5'-hexachlorobiphenyl and Aroclor 1260. The PCBs, dissolved in isopropanol, were applied 20 times to the clipped and shaved backs of three groups of four rabbits each, 5 times/week for 4 weeks. The control group received only isopropanol. The Aroclor 1260 sample was found to be "free" of chlorinated dibenzofurans (limit of detection, 1 ppm), and because of the nature of the chemical reactions utilized in the synthesis of 2,2',4,4',5,5'-hexachlorobiphenyl. Dermal applications of these PCBs resulted in early macroscopic skin lesions and morbid liver changes similar to those found by Vos and Beems [208]. These liver lesions included centrilobular degeneration and liver cell atrophy, focal cytoplasmic hyaline degeneration of the hepatocytes, enlarged nuclei, loss of glycogen and proliferation of SER. The authors [225] concluded that, although the

major acnegenic action of crude PCB mixtures results from the presence of chlorinated dibenzofurans, PCBs have acnegenic actions of their own.

Hansell and Ecobichon [217] described the effects of a series of chemically pure chlorobiphenyls on rat liver morphology. Biphenyl and a series of isomerically pure mono-, di-, tetra-, hexa-, and octachlorobiphenyls of known composition were administered intraperitoneal (ip) injections in daily doses of 50 mg/kg to groups of seven young male Woodlyn strain Wistar rats for 3 consecutive days. The rats were killed 4 days after the final injections had been made and sleeping times after phenobarbital administration had been determined. The major microscopic alterations observed were proliferation of the hepatocytic SER, changes in the rough endoplasmic reticulum, and increased numbers of lipid droplets and microbodies. However, in the rats administered isomerically pure hexa- and octachlorobiphenyls, there were additional changes in hepatic morphology, including large numbers of hepatocytes with cytoplasmic vacuoles and small foci of necrosis involving five or six cells. Biphenyl and 2,2'-dichlorobiphenyl appeared not to induce extensive proliferation of the SER, but with the other compounds the SER proliferation appeared to be related to the degree of chlorination, especially to the presence of a chlorine in the 4 and/or 4' positions.

The investigators [217] also injected groups of seven rats ip with daily doses of 100 mg/kg of either 4-mono-, 4,4'-di-, or 2,5,2',5'-tetrachlorobiphenyl for 7 days; all rats from each group were killed 24 hours after the last injections. This regimen caused more pronounced alterations in hepatocytic ultrastructure than those observed after the 3-day experiments. Marked proliferation of SER and increased numbers of

microbodies and lipid droplets were noted, as were a large number of necrotic foci, centrilobular necrosis, and proliferation of biliary ductules. The most severe lesions were seen in the group receiving 4,4'-dichlorobiphenyl. There was not the increase in hepatic weight and cell size noted by other authors [219,226]. Hansell and Ecobichon [217] observed that this apparent anomaly may have been due to the duration of PCB administration, only 3-7 days, and to the relatively low dosages.

Allen et al [226], in a series of experiments, studied the toxicity of 2,2',5,5'-tetrachlorobiphenyl in rats and rhesus monkeys. In the first experiment, 5-week-old rats were separated into five groups consisting of five males and five females each. After being fasted overnight, each of these groups was administered by gavage a single dose of one of the following amounts of the compound dissolved in corn oil: 0, 0.5, 1.0, 1.5, or 2.0 g/kg. Each dose had a total volume of 1 ml. After the dose had been given, blood was taken for complete blood counts. Eighteen of the 40 PCB-dosed rats died within 3 days. The dead animals included all those given 2.0 g/kg, 7 rats from the group given 1.5 g/kg, and 1 rat from the 1.0 g/kg group. The rats were observed for 21 days after which complete blood counts were performed and the surviving animals were killed and necropsied. The major pathologic changes observed in the animals that died were marked regressions of lymphocytes in the spleen and lymph nodes and of cortical thymocytes. With the exception of hemorrhage and atrophy of the thymus, which were related to the decrease in the cortical thymocytes, and enlargement of the liver and kidneys, all tissue samples were normal when compared with those from the nonexposed group.

The second experiment was conducted to determine the effects of hepatic microsomal enzyme activity on the responses of male Sprague-Dawley rats to 2,2',5,5'-tetrachlorobiphenyl [226]. The rats were separated into 6 groups of 10 animals each. Group 1 was a positive control given four ip injections of 75 mg/kg of the microsomal enzyme inhibitor, SKF 525A, at 8-hour intervals. Group 2 was given four daily sc injections of 75 mg/kg of phenobarbital. Group 3 was the general control. Groups 4, 5, and 6 received 1.25 g/kg of the chlorobiphenyl in 1 ml of corn oil by gastric intubation; group 5 was dosed with the chlorobiphenyl 24 hours after 4 days with daily sc doses of 75 mg/kg of phenobarbital. Group 6 received 75 mg/kg of SKF 525A ip 2 hours prior to administration of 2,2',5,5'-tetrachlorobiphenyl, and every 8 hours thereafter for 24 hours. Within 4 days, all the rats in group 5 and 50% in group 4 had died whereas none had died in group 3, which was pretreated with phenobarbital. The findings that pretreatment with phenobarbital allowed complete survival of rats after an LD50 dose of the PCB, whereas pretreatment with SKF 525A caused 100% mortality, indicated to the investigators that metabolic transformation by endoplasmic reticulum enzymes resulted in detoxification [226].

The third experiment was performed to compare the differences between the responses of rats to 2,2',5,5'-tetrachlorobiphenyl and Aroclor 1248 [226]. Twelve male rats were placed in three groups of four animals each; group 1 was fed 100 ppm of Aroclor 1248 in its diet, group 2 was given 100 ppm of the 2,2',5,5' isomer in its diet, and group 3 (control) was fed the staple ground meal diet. After 4 weeks of these feeding regimens, the rats were fasted for 24 hours, killed, and necropsied; blood was also collected

at this time. There were no detectable differences in general appearance, food consumption, activity, growth rate, or blood chemistries between the two experimental groups and the control group. The only significant difference at autopsy was an increase in liver weight as a percentage of body weight of the animals fed Aroclor 1248: $4.46 \pm 0.11\%$, compared with $3.38 \pm 0.13\%$ for those fed 2,2',5,5'-tetrachlorobiphenyl and $3.0 \pm 0.12\%$ for the controls. Proliferation of the endoplasmic reticulum within the hepatic cells was observed in the Aroclor 1248-fed animals. The N-demethylase activity and the cytochrome P-450 content of the microsomal fraction of homogenized liver from the Aroclor 1248-fed rats were increased whereas the activity of aniline hydroxylase and glucose-6-phosphatase in this fraction had decreased. There were increases in the concentrations of protein and RNA and a decrease in the DNA content of the liver homogenates from the Aroclor-fed animals. The livers of rats fed the isomer had similar but less marked changes in concentrations of protein, RNA, and DNA. The mean concentration of microsomal protein in liver was identical with that of the controls but was more variable. A significant increase in the mean activity of N-demethylase was found.

The fourth experiment [226] was performed to determine the effects of 2,2',5,5'-tetrachlorobiphenyl on non-human primates. Seven adult male rhesus monkeys were given 18 mg/kg of the PCB isomer dissolved in 2.5 ml of corn oil and three controls were given 2.5 ml of corn oil, all by gavage after a 24-hour fast. Complete blood counts had been done on each animal prior to intubation. Immediately after treatment, the animals were placed in metabolism cages and their urine and feces analyzed for 2,2',5,5'-

tetrachlorobiphenyl by GLC. On the 14th day of the experiment the animals were fasted for 24 hours, killed, and necropsied. Tissues were taken for light and electron microscopy and GLC. No overt clinical effects were seen in the treated monkeys. Over 12% of the PCB was recovered unmodified in the feces but only minute amounts were present in the urine. Only the adipose tissue and adrenals had high PCB assays, and microscopically, except for a moderate proliferation of hepatocytic SER, all tissues were normal. DNA was slightly decreased in liver homogenates of exposed animals and hepatic microsomal cytochrome P-450 was increased.

Torok [227], in 1976, reported a study of pregnancy in NMRI mice treated with 2,2'-dichlorobiphenyl. The mice were separated into three groups, with group 1 (37 mice) serving as the control; group 2 (18 mice) received the PCB in oral doses of 375 mg/kg/day on days 1-3 of gestation, and group 3 (37 mice) received 750 mg/kg/day on the same schedule. Administration of the PCB at either level resulted in longer intervals from breeding to parturition: 18.2 days for controls, 19.4 days for mice treated with the PCB at 375 mg/kg/day, and 21.8 days in mice treated at 750 mg/kg/day. There also were reductions in the numbers of dams with litters and in the mean litter size. Reductions were greatest in group 3. The authors [227] concluded that the effects were due to delayed implantation.

(d) Reproductive and Teratogenic Effects of PCB Mixtures

Curley et al [101] studied the transplacental movement of PCBs in rats. Three groups of 90-day-old female rats were paired with male rats of the same age. All were fed standard laboratory chow by the authors, who designated the day of insemination as day 0. Aroclor 1254 was given in

doses of 0, 10, and 50 mg/kg in peanut oil (presumably by oral intubation) once a day on days 7 through 15 of pregnancy to groups 1, 2, and 3, respectively.

On the 20th day after insemination, fetuses were taken by Caesarean section from three rats of each PCB-exposed group and from two control rats. The fetuses from each experimental group were divided into two lots and analyzed as duplicate samples for PCBs. Ten rats from each of the three experimental groups were allowed to deliver spontaneously. When the offspring were 5 days old, six mothers from each exposed group and two from the control group were separated from their litters for several hours and then returned for 1 hour of nursing. The contents (milk) of the pups' stomachs were analyzed for PCBs. Litters from three rats in each experimental group were allowed to survive until weaning at 21 days of age. These baby rats then were killed and their tissues analyzed for PCBs by GLC with EC detection [101].

The rats subjected to Caesarean section had normal fetal complements, in both size and number, and in the rats allowed to deliver spontaneously there were no significant differences in average litter size and weight among the three groups. However, the three groups, with 0, 10, or 50-mg/kg doses of Aroclor 1254, had 0, 1, and 4 stillbirths on the average, respectively [101].

Analyses of the tissues of the Caesarean-delivered pups showed measurable levels of PCB-derived components in the exposed groups only. The mean PCB concentrations were <0.12 , 0.63 ± 0.06 , and 1.38 ± 0.06 $\mu\text{g/g}$, respectively, for groups 1, 2, and 3. Although the PCB dose for group 3 was five times that of group 2 (50 vs 10 mg/kg Aroclor 1254), the average

amount of PCB-derived components measured in the fetuses from these two groups differed by only two-fold. The authors suggested that the PCB distribution between the mothers and their fetuses may not have been uniform and that a partial (unspecified) barrier may have existed [101].

Livers were increased in size and had enlarged hepatocytes in 15 of 21, and 15 of 20 weanling rats from groups 2 and 3, respectively. Some rats from group 3 showed vacuolization of the hepatocytic cytoplasm (10 of 20), and 5 of 20 exhibited bile duct proliferation. Morphologic changes in the liver were more pronounced at the higher dose [101].

PCB-derived components were detected in litter-pooled milk at mean concentrations of <0.75 , 20.60 ± 1.59 , and 66.34 ± 8.36 $\mu\text{g/g}$ in groups 1, 2, and 3, respectively. The authors [101] concluded that the morphologic changes identified in the livers of exposed weanling rats were probably caused by PCBs transmitted to the pups in the milk from the dams [101].

Reproductive effects of feeding Aroclors 1254 and 1260 to Sherman strain rats for two generations were reported by Linder et al [228] in 1974. In preliminary experiments, the two mixtures were fed to groups of 10 females at 100 and 500 ppm in the diet. Two similar groups served as controls. The diets, fed for 67 days before the first mating, were continued through gestation and lactation. After weaning of the first litters, the parents continued to be fed the diets. After being fed PCBs for a total of 186 days, they were again mated and the diets fed through the second gestation and lactation. Feeding Aroclor 1254 at 500 ppm resulted in only 4 first litters being born (2 alive), with no survivors to weaning. Consequently, feeding Aroclor 1254 at 500 ppm was discontinued. With Aroclor 1254 at 100 ppm, there was little indication from either the

first or second mating of reduced fertility, or increased death in utero or during the nursing period. Aroclor 1260 fed at 100 ppm for 67 days had no apparent effect on reproduction, litter size, or survival of the first litters; however after being fed for 186 days, only 5 second litters were born from 9 mated females, compared to 9 out of 10 in the controls. At 500 ppm, Aroclor 1260 resulted in more pups dead at birth in first litters, reduced second litter size, and fewer litters being weaned (3 of 8 first litters; 2 of 6 second litters).

Subsequently, Linder et al [228] fed groups of 20 female Sherman rats Aroclor 1254 at 1, 5, 20, and 100 ppm and Aroclor 1260 at 5, 20, and 100 ppm. Appropriate control groups with similar numbers of rats were used. The experimental plan was similar to that described above except that the F1 generation pups continued to be fed the F2 generation diet until they reproduced the F2 generation. The first matings of the F1 generation were after they were exposed to PCBs in utero, in milk, and in the diet for 125-129 days. The F1 generation rats fed Aroclor 1254 at 20 and 100 ppm were mated a second time after a total of 274 days of PCB exposure.

Rats exposed to Aroclor 1254 at dietary levels of 20 ppm or more had fewer pups in their litters than the controls [228]. There were also fewer F2 generation pups than controls. Second litters born from rats fed 100 ppm of Aroclor 1254 had increased mortality and markedly decreased mating performance. Dietary levels of 5 ppm Aroclor 1254 and 100 ppm Aroclor 1260 had no effect on reproduction in rats exposed through two generations. Liver weights were increased in 21-day-old F1 male weanlings at 1 ppm of Aroclor 1254 and in either sex of F1 and F2 weanlings at 5 ppm or higher of both Aroclors 1254 and 1260.

Villeneuve et al [229], in 1971, wrote about fetotoxic effects of Aroclors 1221 and 1254 in rabbits. Twenty-four mature female rabbits were divided into six groups each comprised of two control and four experimental does. Experimental animals were given the Aroclors orally at 1.0 and 10 mg/kg/day beginning after mating and continuing through gestation. They were killed 28 days after mating. Neither Aroclor had a fetotoxic effect at either dose level. Liver weights expressed as percentages of body weight were significantly heavier in the does fed 10 mg/kg Aroclor 1254 than in controls (4.29 vs 2.79%). Liver weights of the other experimental does and of all fetuses were not significantly different from controls.

In another experiment reported by Villeneuve et al [230], 16 mature female rabbits were separated into four groups and, after mating, were dosed orally with 0, 12.5, 25, or 50 mg/kg of Aroclor 1254 daily for the first 28 days of gestation. The 50-mg/kg group had three pregnancies. One pregnant female died on the 11th day and contained nine fetuses. A second one died on the 17th day and contained six resorption sites. The third female aborted three dead fetuses on the 28th day. Two rabbits in the 25-mg/kg group had normal fetuses. A third rabbit aborted her litter on the 28th day and died. The four animals in this group showed an average weight loss of 26 g and liver weights found at autopsy 29 days after mating averaged 3.11% of their body weights. Autopsies were performed on the fetuses of the two rabbits which had conceived in the 12.5-mg/kg group; the first rabbit had two normal fetuses, with six resorption sites, while the second aborted two fetuses on the 27th day and was found on autopsy to contain one partially resorbed and two dead fetuses. The two dead fetuses obtained on autopsy showed subcutaneous cephalic hemorrhages and had

asymmetric skulls. Average weight gain of the females during pregnancy was 265 g, and their liver weights averaged 6.03% of their body weights. Controls gained 654 g during pregnancy, and their livers averaged 2.66% of their body weights.

In their third experiment, Villeneuve et al [230] gave each animal in three groups of six female rabbits 25 mg/kg Aroclor 1254 in corn oil (orally). Controls received corn oil alone. A control group and one exposure group were dosed from day 1 through day 28, and another control and an exposure group were dosed from day 7 through day 28. Administration of Aroclor 1254 at 25 mg/kg/day from day 1 through day 28 resulted in abortions in two of four rabbits. Their average weight gain was 245 g and liver weights averaged 6.03% of their body weights (controls, 531 g weight gain; liver weights, 2.65% of body weight). In the second group administered PCBs, one of four rabbits aborted. Average weight gain was 156 g and the liver weights averaged 4.82% of the body weights.

PCB concentrations in various tissues of six rabbits and their fetuses, chosen at random from the above groups, were determined by Grant et al [231]. Concentrations of PCBs were higher in the livers of the fetuses than in their mothers: 5.4 vs 2.1 ppm at a dose of 1 mg/kg; 78.1 vs 69.5 ppm at 12.5 mg/kg; and 375.3 vs 124.2 at 25 mg/kg. In other tissues, PCB concentrations were generally less in the fetuses than in the dams.

Allen et al [232] in 1974 presented evidence of possible fetotoxicity in a short term PCB feeding experiment with 12 adult female rhesus monkeys. The monkeys ranged in age from 7 to 10 years and had an average weight of 5.6 kg. Each previously had delivered at least one infant and the menstrual cycle of each had been recorded for at least 2 years. Six of the

monkeys were fed an unspecified diet containing 25 ppm of Aroclor 1248 for 2 months. The other six monkeys were controls. After 2 months, the PCB-exposed animals were placed on PCB-free diets of commercial monkey chow.

The monkey which had consumed the largest amount of PCBs died on the 128th day of the experiment [232]. At the beginning of the 5th month, ie, 3 months after the test animals had been removed from the PCB-containing diet, the remaining five test monkeys and the six controls were mated again. Three PCB-exposed monkeys were thought to have conceived since each showed the characteristic post-conceptual bleeding, lack of the subsequent menstrual period, and an enlarged uterus. Two either aborted or reabsorbed their fetuses during the 2nd month of pregnancy and the third monkey delivered a well-developed but smaller-than-normal ($375 \text{ g} \pm 1 \text{ g}$ vs $544 \text{ g} \pm 101 \text{ g}$) infant. High concentrations of PCBs were found in the adipose tissues and adrenals of this infant with means of 27.7 and 24.4 $\mu\text{g/g}$, respectively, as compared to a range from 0.01 to 0.98 $\mu\text{g/g}$ in the other infant tissues analyzed. The PCB levels in the placenta averaged 0.9 $\mu\text{g/g}$, and 50 $\mu\text{g/g}$ in the mother's adipose tissue. Two additional attempts were made to breed the nonpregnant females during the next 5 months. Only the controls became pregnant and all delivered normal infants. Six of the monkeys were fed an unspecified diet containing 25 ppm of Aroclor 1248 for 2 months. The other six monkeys were used as controls. After 2 months, the PCB-exposed animals were placed on PCB-free diets of commercial monkey chow.

In 1976, Barsotti et al [233] and Allen and Barsotti [234] reported their findings on reproductive dysfunction in female and male adult rhesus monkeys fed Aroclor 1248 in their diets. One test group of female monkeys

received 2.5 ppm and the other group received 5.0 ppm of Aroclor 1248 in a commercial diet. The control group, containing 12 females and 6 males, was fed the commercial diet alone. Females received 200 g, and the males received 300 g of their respective diets daily. Food left in the feeding cups at the end of the day was removed and weighed to determine the daily intake. After the end of the first 6 months, the average PCB intakes were 180 and 364 mg for females fed the 2.5- and 5.0-ppm diets, respectively [233].

Some of the exposed females began to exhibit the characteristic skin and blood chemistry signs of PCB intoxication within 2 months. At 6 months, all exhibited these signs in varying degrees. Menstrual cycles were irregular and menstrual bleeding was excessive and prolonged [233].

The conception rates for the control females and for those fed the 2.5-ppm Aroclor diet were 12 of 12 and 8 of 8, respectively, whereas 6 of 8 females fed the 5.0-ppm Aroclor diet conceived [233]. All 12 of the control group pregnancies resulted in normal births, compared to 5 and 1, respectively, for the exposed females fed the 2.5- and 5.0-ppm diets. Three of the eight fetuses of monkeys fed the 2.5-ppm Aroclor diet were resorbed shortly after conception. Profuse uterine hemorrhaging was observed rather than the implantation bleeding which usually occurred 17 days after conception, according to the authors [233]. The two females from the group fed the 5.0-ppm diet who did not conceive initially were bred five times without success. Of the six females of this group that did become pregnant, three aborted at 46, 67, and 107 days of gestation; one fetus was resorbed, one was stillborn, and one delivered normally. The six live infants born to PCB-fed mothers had body weights that were less than

normal for the colony by one to two standard deviations. These infants began showing signs of PCB toxicity (acne, swollen eye lids, increased skin pigmentation) after nursing their mothers for less than 2 months [234]. In samples obtained from three of their mothers after the infants developed the poisoning signs, the milk contained PCBs at 0.154-0.397 ppm, and the milk fat from a fourth mother contained 16.44 ppm. Three of the infants died 44-112 days after birth.

The effects of Aroclor 1254 on reproductive performance and fetal integrity were evaluated in beagle dogs and Hormel miniature swine by FL Earl et al (written communication, 1976). Aroclor 1254 was administered orally in capsules as a solution in corn oil to 46 purebred beagle bitches once daily after the 1st day of gestation. Ten bitches were given 0.25 mg/kg/day, 16 were given 1 mg/kg/day, and 20 were given 5 mg/kg/day. Sixteen untreated bitches served as controls.

The data presented show that Aroclor 1254 at 5 mg/kg/day significantly interfered with reproductive performance and was teratogenic in the beagle. When Aroclor 1254 was administered at 0.25 and 1.0 mg/kg/day, no effects on reproduction were observed but the incidence of patent fontanelles in the offspring of the 1.0-mg/kg/day group was increased sharply. Dosage at 5.0 mg/kg/day resulted in 45.5% resorptions (4-fold increase over the control rate) and an average of only two live pups per litter. Patent fontanelles were present in 50% of the offspring.

Earl and his coworkers fed Aroclor 1254 to Hormel miniature swine in doses of 1.0 (4 sows), 10.0 (6 sows), and 30.0 (7 sows) mg/kg/day for 21 days before breeding and throughout gestation. Five sows served as controls. The 1-mg/kg/day dose produced a statistically significant

percentage of fetal resorptions (23%). Increasing the dose to 10 mg/kg/day lowered the fertility rate to 50% (80% in controls) and increasing the dose to 30 mg/kg/day lowered the fertility rate to 43%. Cleft palate and syndactyly in three feet were observed in one fetus from the group fed 10 mg/kg/day. At this dose level, there was also a significant decrease in survivability with only 71% of the offspring alive after 5 days. At the 30-mg/kg/day dose, 14 of the 15 implantations were resorbed and teratogenic abnormalities were present in 100% of the observed fetuses. Cleft palates, syndactyly, and patent fontanelles were the teratogenic effects observed. The fact that pigs are normally born with closed fontanelles increases the significance of the teratogenic findings.

(e) Studies on Mutagenicity and Cytotoxicity

To evaluate the effects of PCBs on the testes of rats, Dikshith et al [235] administered, by oral intubation, 50 mg/kg/day of Aroclor 1254 dissolved in corn oil to a group of 18 adult male Sprague-Dawley rats for 7 consecutive days. A control group of 18 rats received corn oil without PCBs. Three rats from each group were killed 1, 7, 15, and 30 days after the last PCB administration. The testes and epididymises were separated and weighed, as were the livers. Microscopic, histochemical (acid phosphatase), and cytogenetic examinations were performed. Rats used for cytogenetic examination were injected ip with colchicine 2 hours before being killed and the chromosomes in testicular tissues were examined.

No effects on weight or gross appearance of either the testes or epididymis were noted, nor was there evidence of atrophy or hypertrophy of the testes. The only structural changes noted in the testes of the exposed group was a proliferation of interstitial tissue cells. These cells showed

an increase in acid phosphatase activity, which, according to the authors [235], denoted a change from particulate enzyme localization in testicular interstitial cells of the controls to a disseminated, diffuse localization in the testes of the exposed group.

Cytogenetic analyses showed similar chromosomal configurations in both the control and the exposed groups. In the PCB-treated rats, some apparently sporadic abnormal chromosomes were seen in a few of the metaphase figures; chromosomal abnormalities also included breaks, exchange figures, chromatin bridges at anaphase, and chromosome fragments. The significance of these findings was unclear to the authors [235].

Green et al [236] looked for mutagenic effects in the bone marrow and spermatogonial cells of male Osborne-Mendel rats fed various doses of PCBs. Rats were given Aroclor 1242 either in single oral doses of 1,250, 2,500, or 5,000 mg/kg or in multiple oral doses of 500 mg/kg/day for 4 days. Aroclor 1254 was administered orally in daily doses of 75, 150, or 300 mg/kg for 5 days. The Aroclors were mixed with corn oil, except the 5,000-mg/kg dose of Aroclor 1242, which was given undiluted. Controls were fed uncontaminated corn oil. The animals were given Colecimid (a colesticline derivative) at 4 mg/kg 24 hours after PCB dosing was completed and they were killed 3 hours later.

Aroclor 1242 produced no statistically demonstrable evidence of chromosomal damage in bone marrow cells at doses of 1,250 or 2,500 mg/kg, or at the 500-mg/kg dose level [236]. At 5,000 mg/kg, there appeared to be an increase in the number of chromosomal abnormalities. However, since most of the changes occurred in one animal, the findings were not considered to be significant. Aroclor 1254 did not produce statistically

significant numbers of chromosomal abnormalities in bone marrow cells at any dose level tested. A statistically significant number of chromosomal abnormalities was not identified in spermatogonial cells from rats fed Aroclor 1242. Spermatogonial cells from rats given Aroclor 1254 were not examined since the results with the more acutely toxic Aroclor 1242 were negative. All observed chromosomal lesions were single chromatids. The authors [236] did not exclude the possibility of point mutations since the procedures used in this experiment would not have detected such damage.

Green et al [237] also investigated the possible induction of dominant lethality in rats given Aroclor 1242 or Aroclor 1254 by oral intubation. Except for the positive controls, results showed nonreproducible positive effects that were not related to dose or stage sensitivity. The authors concluded that the two Aroclors did not appear to be mutagenic.

Wyndham et al [116] performed the "Ames" bacterial test for mutagenicity on a variety of PCBs, using Salmonella typhimurium mutant strain TA1538. A comparison was made of the mutagenic potentials of Aroclor 1254, 2,2',5,5'-tetrachlorobiphenyl, Aroclor 1268, Aroclor 1221, and 4-chlorobiphenyl. The results showed clearly that as the degree of chlorination decreased, the mutagenic potential increased. A concentration of 100 µg of 4-chlorobiphenyl in the test medium gave over 2,000 revertant colonies/plate. The more highly chlorinated biphenyls showed very little activity as mutagens.

Hoopingarner et al [238] studied the toxicities of various Aroclors at 50 ppm in the culture medium of Chinese hamster cells, and found increasing toxicity (measured by cell population survival) with decreasing

chlorination. Aroclor 1016 appeared to be disproportionately cytotoxic, on the basis of its chlorine content, suggesting to the authors that this product contained certain toxic components in higher proportions than either Aroclor 1232 or Aroclor 1242, which it resembled chromatographically. Aroclor 1254 at 100 ppm showed no apparent effect on the chromosomal integrity of human lymphocytes in vitro.

Popper et al [239] studied the effect of hepatic microsomal biotransformation systems from control mice and from mice treated with PCBs on the mutagenic potentials of the primary carcinogen N-methyl-N'-nitro-N-nitrosoguanidine (MNNG), and the secondary carcinogen dimethylnitrosamine (DMN). Hepatic microsomes were isolated from male Swiss-Webster mice that had been given 500 mg/kg of Aroclor 1254 4 days earlier, and from untreated control mice. The mutagenicities of MNNG and DMN were assayed by a bacterial auxotroph reversion test using Bacillus subtilis.

Microsomes prepared from the livers of the PCB-treated mice had 2-3 times as much cytochrome P-450 activity as the controls [239]. DMN added directly to the cultures was not mutagenic at concentrations as high as 300 mM. However DMN was converted to a mutagen when exposed to such microsomes in the presence of an NADPH-generating system. When MNNG was incubated with isolated microsomes, its mutagenic activity was reduced. The authors concluded that isolated hepatic microsomes can modify the biologic activities of mutagens and that the hepatic microsomal biotransformation system could play a key role in chemical mutagenesis.

(f) Studies on Tumorigenesis

Kimbrough et al [218] distributed 400, 21- to 26-day-old weanling, Sherman strain, "COBS" female rats randomly into two equal-size groups.

Half of the rats were fed a plain commercial laboratory chow. The other 200 were fed laboratory chow containing 100 ppm of Aroclor 1260. The dosed group of rats was fed the PCB diet until 6 weeks before they were killed at the age of 23 months. Autopsies were performed on these rats as well as those that died before the exposures ended.

Microscopic examination was completed on 184 dosed animals and 173 controls. From a few to multiple elevated tan nodules were found on the liver surfaces of 170 PCB-fed rats. The nodules varied from 0.1 to several cm in diameter. Only one such abnormality was found in the controls. Of the tumors, 26 of those in exposed animals and the 1 from the control animal were hepatocarcinomic; the other 144 experimental animals had hepatocellular nodules that were described as characteristic of neoplastic nodules or synonymously, hyperplastic nodules. The authors [218] said "neoplastic nodules are part of the spectrum of response to hepatocarcinogens and must be included in the evaluation of tumorigenesis." Tumors identified and analyzed from other organs had no unusual features; no apparent differences in incidence were observed between the experimental and control groups [218].

Evidence of PCB-induced hepatocarcinomas was reported by a group of Japanese investigators in 1972 [240] and in 1973 [241]. Nine groups of 12 male dd mice were fed a commercial stock diet supplemented with 100, 250, or 500 ppm of Kanechlors 300, 400, or 500. A control group of eight mice was fed the stock diet. All mice were given water ad libitum. After 32 weeks, the animals were starved for 18 hours, killed, and examined macroscopically for tumors. Seven of the 12 mice fed Kanechlor 500 at 500 ppm developed hyperplastic liver nodules and five had well-developed

hepatocellular carcinomas. None of the mice fed Kanechlor 500 at lower concentrations or Kanechlor 400 or 300 at any concentration developed hepatocarcinomas.

In 1973, Kimura and Baba [242] described neoplastic changes in the livers of rats exposed to Kanechlor 400. Thirty 10-week-old rats were separated into an experimental group of 10 males and 10 females and a control group of 5 males and 5 females. The experimental group was fed a diet supplemented with olive oil containing various concentrations of Kanechlor 400. The control group received an olive oil-supplemented diet. The diet of the experimental group of rats contained 38.5 ppm of Kanechlor 400 for the first 4 weeks, followed by 77 ppm for 8 weeks, 154 ppm for 3 weeks, 308 ppm for 3 weeks, and 616 ppm for 8 weeks. Body weights were checked weekly and showed rapid decreases during the 616-ppm feeding period; for this reason the Kanechlor 400 content of the diet was reduced to 462 ppm for the next 32 weeks. The total feeding period for the experimental and control animals was about 58 weeks (400 days).

All rats that ingested total doses of more than 700 mg of Kanechlor 400 developed hypertrophy of the liver [242]. Pale brown nodules were present on the parietal and cut surfaces of the livers of female rats that had ingested more than 1,200 mg of PCBs. However, none of the male rats had such hepatic nodules, despite having ingested equal or greater amounts of Kanechlor 400. On microscopic examination, the livers of female rats were observed to have fatty degeneration and multiple adenomatous nodules that appeared to be benign neoplastic lesions. Males did not develop such neoplastic lesions; however, their livers did exhibit fatty degeneration. Lung abscesses, pneumonia, splenic atrophy, and intracranial abscesses were

found frequently in the experimental group. The authors [242] thought that resistance to infection was lowered in the rats fed Kanechlor 400.

A formal rulemaking hearing was convened August 20, 1976 by the US Environmental Protection Agency on its proposed toxic pollutant water effluent standards for PCBs (Federal Register 42:6532-55, February 2, 1977). Part of the testimony concerned comparative studies in which groups of 100 male and female Charles River rats were fed 1, 10, and 100 ppm of Aroclors 1242, 1254, or 1260 for 24 months. The survival of the rats was poor and the experiment was said to have been inconsistently reported. A reevaluation of the pathology slides revealed the occurrence of liver tumors (hepatomas and cholangiohepatomas) in the rats fed any one of the three Aroclor products. The incidence of liver tumors in the rats dosed at 100 ppm was 3/20 for Aroclor 1242, 6/27 for Aroclor 1254, and 7/27 for Aroclor 1260, compared with 0/20 for the controls. In addition to the tumors there was a high frequency of nodular hyperplasia. The incidence of nodular hyperplasia at 100 ppm was 8/20 for Aroclor 1242, 13/27 for Aroclor 1254, and 7/27 for Aroclor 1260, compared with 1/23 for the controls. Nodular hyperplasia in the rats dosed at 10 ppm occurred in 2/10 for Aroclor 1242, 3/26 for Aroclor 1254, and 9/23 for Aroclor 1260, and 1/23 for the controls. The incidence of tumors of the pituitary gland also was elevated in each treated group.

Correlation of Exposure and Effect

(a) Absorption, Metabolism, Excretion, and Body Burdens

It has been demonstrated in experimental animals that PCBs can be absorbed into the blood from inhaled air [97] and from the digestive tract

[50,51,95,96]. Qualitatively, the effects in experimental animals from absorption by either route were similar [98,99,202-206]. When PCBs were applied to the skin, certain effects, such as those on the liver, were similar to those obtained when PCBs were ingested or inhaled [205-208]. Thus, it appears that PCBs were also absorbed by this route.

In experimental animals, most PCB isomers were metabolized in varying degrees to more polar compounds such as hydroxylated derivatives [41,48,49,51-56,58-81,85,87]. The more highly chlorinated isomers were metabolized slowly and accumulate in the tissues [41,50,51,55,61-64,66,82-84,96,103,107-110]. The hydroxylated derivatives were excreted in the bile, urine, and milk [41,48,50-56,58-61,63-66,69,71-80,85]. Unmetabolized compounds were excreted in feces, milk, and hair [41-44,50,51,53-56,100-102], and traces were found in urine [42,51-55,57-62,103-105].

In man, the metabolism of PCBs has not been studied. However, finding that PCB isomers that are difficult to metabolize become concentrated in residual PCBs of tissues from the general population, from persons who have ingested PCBs, and from those with occupational exposure suggests that man metabolizes, eliminates, and stores the compounds in ways similar to those of animals [7,36,136,168,171-175]. Determinations of PCBs or their metabolites in urine or feces of humans have not been reported. PCBs have been found in human hair [102,142]. Excretion in human milk of PCBs with compositions similar to those in blood, has been reported in association with general environmental exposures and following ingestion and occupational exposures [143,144,168,192]. These findings of PCBs in human hair and milk also suggest metabolism and excretion similar to those of animals.

Because PCBs are widespread in the environment, detectable concentrations have been found in tissues and body fluids of a substantial portion of the US population [36,102,134,135,137,140,144]. Detectable concentrations have been found in up to 62% of blood serum samples, with concentrations ranging up to 30 ppb [137]. In emaciated patients, blood PCB concentrations as high as 100 ppb have been found [140]. PCB concentrations in about three-fourths of adipose tissue samples from the general population were <1 ppm, and the remainder were mostly in the range of 1-2 ppm [36,136]. Usually the PCB isomers found in blood and adipose tissue have been penta-, hexa-, and heptachlorobiphenyls [7,135,136], and a high correlation was found between the concentrations in these two tissues [141]. PCB isomers in cord blood were qualitatively identical to those in maternal blood [138]. PCB isomers excreted in human milk were similar or identical to those in blood [168], and the concentrations in milk were positively correlated with adipose tissue concentrations [143]. In human milk samples from the general US population, PCB concentrations up to 13 ppm (fat basis) have been reported (EP Savage, written communication, February 1977).

These concentrations of PCBs in blood, adipose tissue, and milk of the general US population arise from dietary intakes estimated to be of the order of 10-20 µg/day [46] and from inhalation of air that may contain up to 100 ng/cu m [26,38].

(b) Irritation Effects and Chloracne

The first reports of adverse effects of PCBs on workers included chloracne [120,123,130], digestive disturbances [123], irritation of mucous membranes [120,123,130], and impotence [123]. The exposures associated

with these effects were not well-defined either qualitatively or quantitatively. When PCBs were first being manufactured, (in mostly open systems) the exposures were to benzene and unidentified intermediates in addition to PCBs [120]. Jones and Alden [120] and Schwartz [123] did not report exposure concentrations in their studies. However, Drinker et al [125] indicated that average concentrations of PCBs ranged from about 0.5 to 1.5 mg/cu m in 30 factories, which may have included the factories studied by Schwartz [123]. On the basis of these reports [120,123,125], it would appear that chloracne and some other systemic effects occurred with early PCB preparations when their average concentrations in workroom air were below 1.5 mg/cu m. Elkins [130] found that airborne PCB concentrations approaching 10 mg/cu m in capacitor-impregnating operations in Massachusetts were "unbearably" irritating to the workers, but there were no apparent toxic effects with concentrations that averaged up to 5.8 mg/cu m. Elkins [130] did not describe the processes or the PCBs used.

Puccinelli [186] found that when capacitors were filled with Aroclor 1254 heated to 70-80 C, PCB concentrations of about 5-7 mg/cu m resulted. The workers studied by Puccinelli [186] developed chloracne after 4-8 months of exposure. In studying similar processes, Hofmann and Maneghini [187] found that chloracne developed after 2.5-4 months of exposure. These investigators [187] also described the development of areas of brown skin on the foreheads of workers. They did not describe the PCBs used or the exposure concentrations. Reports of the development of chloracne in Americans, who worked in operations which used heated PCBs, appeared in 1964 and 1969 [188,189]. In one of the processes [188], an Aroclor with a chlorine content of 65% and containing both PCBs and polychlorinated

terphenyls was used; the PCB used in the other process [189] was not described, but extensive skin exposure from wearing PCB-soiled clothing and from immersion of unprotected hands into the PCB mixture was described.

A case of chloracne that developed in an Australian worker after exposure to Aroclor 1242 at concentrations of 1-2 mg/cu m was reported by Ouw et al [196]. The PCB preparation was heated during a capacitor-filling process. Complaints of process workers included irritation of the face, eyes, and skin. Eczematous rashes were also found on their hands and legs.

In the reports of chloracne development in occupations involving PCBs (where environmental concentrations of PCBs were measured) [125,130,186-189,196], the sampling and analytical methods did not distinguish between vapor and particulate forms of the PCBs. However, a common factor in many of these reports [186-189,196] was the use of heat in the process which would tend to generate PCB vapors.

In their study of capacitor and PCB manufacturing plants in Japan, Hasegawa et al [191] found that concentrations of PCB vapors (or particles <0.1 μ m in diameter) exceeded the concentrations of PCBs in particles >0.1 μ m in diameter. The compositions of PCBs in the particulate were similar to those in the PCB preparations in use, but the less highly chlorinated compounds were concentrated in the vapors. In this study, where PCB vapors ranged from 0.026 to 0.965 mg/cu m and PCBs in the larger airborne particulates ranged from 0.19 to 0.650 mg/cu m (maximum total PCBs of 1.6 mg/cu m), dermal ailments included a brown chromodermatosis of the hands and chloracne. The workers had been exposed to PCBs from <1 to 20 years.

Meigs et al [190] described a process in which chloracne developed where the exposures had to have been to PCB vapors. The PCB which was used

as a heat-exchange medium was not described, but PCB concentrations were reported to be about 0.1 mg/cu m in the workroom air where the workers were exposed. Under these conditions, chloracne developed after a minimum of 5 months of exposure.

Chloracne has also been studied in connection with determinations of PCB concentrations in blood. Hara et al [192,193] found whole blood PCB concentrations of 7 to 300 ppb in Japanese workers engaged in capacitor filling. About 40% of these workers had chloracne and 13% had irritation of the skin. Kitamura et al [194] found PCBs at 320-820 ppb in blood samples from Japanese workers engaged in capacitor manufacture. Skin ailments, including chloracne, were found in 10 of 13 workers studied. Inoue et al [195] found chloracne in a man exposed to PCBs in a silk-glossing factory who had a concentration of about 200 ppb of PCBs in his blood, but they [195] found what were described as relatively mild skin abnormalities in 28 other workers engaged in similar processes who had blood PCB concentrations mostly under 100 ppb (2 had concentrations >100 ppb). Ouw et al [196] concluded from their study of capacitor workers that no adverse effects were found in workers with blood PCB concentrations <200 ppb.

Studies of PCB-exposed workers where chloracne has not been found include those of Levy et al [197], Karppanen and Kolho [198], and Bumgarner et al [199]. In the study by Karppanen and Kolho [198], workers who had been exposed to PCBs for 4 years in a capacitor-impregnating operation had PCB concentrations of 74-1,000 ppb in samples of their blood. The environmental exposure concentrations of PCBs were reported to meet "internationally accepted standards." Other factors of the work situation,

such as the skin protection used, were not reported. In the study by Levy et al [197], workers who had been exposed to PCBs for 2.5-18 years had concentrations of PCBs in samples of their blood ranging from 36 to 286 ppb. PCB exposure concentrations at the time of the study were 0.013-0.264 mg/cu m. Although some of the workers complained of throat or eye irritation, and some skin rashes were found, no cases of chloracne were seen. From the description of the work situation, it is unlikely that skin exposure to liquid or solid PCBs was an important factor in the total exposure of these workers. In their study of refuse workers, Bumgarner et al [199] found blood PCB concentrations to be 4-14 ppb. One possible source of exposure of these workers was airborne incinerator effluents, and it is unlikely that additional exposure from skin contact occurred.

Although skin exposure was unlikely in these two reports [197,199] where chloracne was not found, skin exposure is not necessary for chloracne to develop. Chloracne has been observed in Japanese people estimated to have ingested total PCB doses of 0.3-4 g [146,164-167], and chloracne-like lesions have been produced in experimental rhesus monkeys fed PCBs at 3 ppm in their diets [222].

Thus, although eliminating exposure of the skin through engineering controls and using appropriate protective clothing and work practices will reduce the total absorption of PCBs, these practices will not necessarily eliminate chloracne. The data indicate that chloracne may occur with exposures to PCB vapor concentrations as low as 0.1 mg/cu m for several months, and with PCB concentrations in the blood of about 200 ppb.

(c) Effects Referable to the Liver

Some clinical and autopsy findings in Yusho, the disease that occurred after ingestion of PCB-contaminated rice oil by humans, were indicative of liver injury [155-158,179-181]. These findings included changes in liver cell anatomy considered consistent with microsomal enzyme stimulation and increased SAP activity. Effects that persisted for several years included decreased concentrations of iron and bilirubin in the serum [155,179] and increased serum concentrations of triglycerides. The latter were found to increase with residual concentrations of PCBs in the serum [180].

The maximum amounts of PCBs consumed by individuals manifesting these effects were estimated to have been of the order of 3-4 g total intake over several months [165]. For two Yusho patients a daily PCB consumption of 67 $\mu\text{g/kg}$ for 3 months was estimated [167]. The maximum intake would have been of the order of 50 ppm in the diet or 0.5-1 mg/kg/day. For comparative purposes, absorption of PCBs from inhalation during maximum occupational exposures that have been reported (10 mg/cu m) probably did not exceed 0.15 mg/kg/day.

The extent to which PCB consumption was responsible for the effects on the liver is not known since the contaminated oil also contained PCDFs [20,160] in quantities that could have resulted in a maximum PCDF consumption of 20-50 mg. Autopsy findings 1-3 years after the poisonings indicated unusually high concentrations of PCDFs (0.3-2.5 $\mu\text{g/g}$) relative to PCBs (3.5-5.6 $\mu\text{g/g}$) in liver fat [160].

Although most animal feeding experiments have been conducted with dietary levels of PCBs that are much higher than those ingested by Yusho

patients, others have been conducted with dietary PCB levels that seem to confirm the Yusho findings. Experiments have been reported with various commercial PCB mixtures (Aroclors 1242, 1254, 1260, and Clophen A60) added to the diet at 1-10 ppm [101,209-212,215,228,233]. These experiments demonstrated increased liver weights at all concentrations, dose dependent stimulation of microsomal enzyme activities, detectable proliferation of the SER at concentrations of 10-100 ppm, and other microscopic changes including enlarged hepatocytes, hepatocytic vacuolization, and, with prolonged exposures, development of adenofibrosis.

At high PCB concentrations (>1.5 mg/cu m), inhalation experiments with animals have demonstrated increased liver weights [98,99,202,203]. Microscopic changes similar to those seen from PCB ingestion were found in livers of rats after inhalation of Aroclor 1254 at 1.5 mg/cu m or more [203], and from other commercial preparations (Decachlorodiphenyl and Solvol) at much higher concentrations (>4 mg/cu m) [99,202].

These data from the Yusho poisonings and from animal experiments indicate that hepatic effects seen in human are similar to those seen in animals. They also indicate that some commercial preparations may be less severe liver poisons than others, but the data are not definitive in this regard. The ingestion experiments demonstrated increased liver weights from feeding PCBs at 1 ppm, and increasing evidence of liver injury as dietary PCB levels were increased. A dietary level of 1 ppm may be considered roughly equivalent to a daily intake of the order of 0.01-0.02 mg/kg, which would be somewhat similar to the intake from inhaling PCBs at 1 mg/cu m.

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Several reports of occupational exposures to PCBs have involved the liver in various ways [123,125,127,186,190,191,197,198,200].

In the earliest reports of PCB toxicity [123,135,127], the PCBs were mixed with chlorinated naphthalenes. The mixtures caused many cases of chloracne and, in some cases, jaundice. Liver cirrhosis with superimposed yellow atrophy was found in at least one fatality [125]. Similar findings have not been reported where exposures were to only PCBs in the absence of chlorinated naphthalenes.

Mention of nausea and digestive disturbances in some reports [123,197] may have indicated liver injury. In the study by Schwartz [123], neither liver function test findings nor exposure concentrations were reported. In the Levy et al report [197], liver function tests (SAP, SGOT, SGPT, total bilirubin) performed at the time of the study did not indicate current liver injury. The workers had been exposed to unidentified PCBs at 0.013-0.264 mg/cu m, and blood PCB concentrations were 36-286 ppb. Even though there were no findings of current liver injury, these investigators' [197] examination of past medical records showed occasional findings indicative of slight liver injury (elevated serum enzymes, triglycerides, and uric acid). A report of a worker who was removed from further exposure after experiencing nausea on exposure to an askarel containing Aroclor 1254 was not accompanied by liver function test results or exposure concentration data (In the Matter of General Electric Company, File No. 2833, New York State Department of Environmental Conservation, 1973).

More conclusive studies of liver function were reported by Maigs et al [190], Hasegawa et al [191], Hara et al [192,193], and Ouw et al [196]. Of the workers exposed to vapors of an undefined PCB at 0.1 mg/cu m in the

study by Meigs et al [190], liver function tests were performed on seven. Findings in six of the workers were normal and, in the other one, cephalin flocculation and thymol turbidity tests were on the borderline of abnormality. Hasegawa et al [191] found some changes in liver function tests (increased SGOT, SGPT, and SAP, and decreased serum cholinesterase and lipids) of 99 workers exposed to Kanachlors but the investigators considered that only the decreased serum lipids were significant. PCB exposure concentrations at the time of the study were 0.045-1.6 mg/cu m. The workers had exposure histories of <1 to 20 years. PCB concentrations in blood samples of the workers averaged 370 ppb.

Hara et al [192] did not find evidence of a correlation of serum triglyceride concentrations with blood PCB concentrations during the first year after the work with PCBs was discontinued. However, when the same workers were studied 2 years after stopping work with PCBs, the proportion of workers with elevated serum triglycerides increased as residual blood PCB levels increased [193]. The effect was particularly prominent in workers with residual blood PCB concentrations >50 ppb. In a study of 34 workers exposed to Aroclor 1242 in capacitor manufacture, Ouw et al [196] found individual abnormalities in SGPT, SAP, and serum bilirubin, but average values for the group were normal. Bromsulphalein retention tests were elevated in four workers. Ouw et al [196] considered that there were no adverse responses in workers with blood PCB concentrations below 200 ppb. The PCB exposure concentrations were 0.32-1.44 mg/cu m.

No evidence of impaired liver function was found in other studies [186,194,195,198] where PCB exposures were reported as: Aroclor 1254 at 5-7 mg/cu m for 2-4 years [186]; Kanachlors at >0.25 mg/cu m [195]; and

unidentified PCBs at <1 mg/cu m for 4 years [198].

Evidence relating to impaired liver function from occupational exposures to PCBs is generally consistent with findings in Yusho patients and in animal studies that indicated some effects could be expected from PCB intakes equivalent to PCB inhalation at about 1 mg/cu m. The occupational exposure studies show occasional evidence of liver injury in workers exposed at concentrations of 0.013-0.264 mg/cu m [197], 0.1 mg/cu m [190], 0.045-1.6 mg/cu m [191], and 0.32-1.44 mg/cu m [196]. Whether the observed effects occurred with exposures at the lower end of all these ranges is not known.

The occupational exposure studies also showed delayed recovery of normal serum triglycerides after exposures to PCBs stopped [193]. The elevated serum triglycerides were related to the higher residual blood PCB concentrations, and these in turn were related to the years of exposure. Residual PCBs have repeatedly been shown to be the more highly chlorinated isomers and those metabolized with greater difficulty [7,36,51,83,103,110,135,136].

Summaries of effects of PCBs on humans and animals are presented in Tables III-9 and III-10, respectively.

Carcinogenicity, Mutagenicity, Teratogenicity, and Effects on Reproduction

(a) Carcinogenicity

There is extensive evidence for formation of arene oxide intermediates during the metabolism of PCBs by several species including rhesus monkeys [51,68,69,74,75,81,115,116,118]. Arene oxide formation was also proposed as a plausible intermediate in the metabolism of the slowly

metabolized 2,2',4,4',5,5'-hexachlorobiphenyl [70,79]. Binding PCB metabolites to nuclear components of liver cells has been demonstrated on administration of PCBs to monkeys [51], and to rats [81], and by in vitro experiments [51,82,86,116,117]. This information is sufficient to arouse suspicions that PCBs could have carcinogenic potential in humans.

Hepatomas were produced in 170 of 184 examined female rats fed Aroclor 1260 at 100 ppm from 3-4 to 23 months of age [218], and in 9 of 22 BALB/cj male mice fed Aroclor 1254 at 300 ppm for 11 months [221]. The tumors found in the rats included 26 hepatocarcinomas and 144 neoplastic nodules. Only one liver tumor, a hepatocarcinoma, was found in 173 control rats.

In another report (Federal Register 42:6532-55, February 2, 1977), dose-related incidences of liver tumors were reported in rats fed Aroclors 1242, 1254, or 1260 at 1, 10, and 100 ppm in the diet for 24 months. No liver tumors were reported in rats fed the diets containing PCBs at 1 ppm. Only one tumor, a hyperplastic nodule (neoplastic nodule), was found in 23 controls. Neoplastic nodules were found in the livers of rats fed the diet containing 10 ppm of PCBs (2/10, 3/26, and 9/23 for Aroclor 1242, 1254, and 1260, respectively). Higher tumor incidences were found when diets containing PCBs at 100 ppm were fed (11/20, 19/27, and 14/27 for Aroclors 1242, 1254, and 1260, respectively) and the tumors included hepatomas and cholangiohepatomas (3, 6, and 7 for Aroclors 1242, 1254 and 1260, respectively). In this experiment the incidence of pituitary tumors was high in PCB-fed rats.

In a study sponsored by the National Cancer Institute, Aroclor 1254 was fed to groups of 24 rats at 25, 50, and 100 ppm in the diet. No liver

tumors were found in the controls, in the experimental females at any dose level, or in experimental males fed PCBs at 25 ppm. However, hepatocellular carcinomas were found in a male rat fed Aroclor 1254 at 50 ppm and in two males fed the PCB at 100 ppm. The data also indicated that the incidence of leukemias in males was dose-related (3/24 in controls; 8/24 in rats fed 100 ppm).

Kanechlors have also been found to produce liver tumors when fed to mice and rats [240,241,242]. Of 12 mice fed Kanechlor 500 at 500 ppm for 32 weeks, 7 developed neoplastic liver nodules and 5 had well-developed hepatocellular carcinomas [240,241]. In this experiment which had only 12 mice/group and continued for only 32 weeks, liver tumors were not found with Kanechlors 300 and 400 or with lower dose levels of Kanechlor 500. However in another experiment [242], Kanechlor 400 fed to 10 male and 10 female rats for 58 weeks did produce liver tumors in the females. In this experiment the amounts fed (38-616 ppm) varied from time to time, but were in the 308-616 ppm range for the last 43 weeks.

These findings from animal studies indicated to NIOSH that PCBs have potential carcinogenic activity in humans. They indicate, but do not conclusively demonstrate, with the dietary levels used, that the less highly chlorinated mixtures (Aroclor 1242 and Kanechlors 300 and 400) have less carcinogenic potential than the more highly chlorinated mixtures (Aroclors 1254 and 1260 and Kanechlor 500). However, all PCB mixtures adequately tested in rats and mice have shown carcinogenic activity. The intakes of PCBs at the lowest dietary level that has produced tumors in rats (10 ppm) would be somewhat comparable to intakes from occupational exposures at 5-10 mg/cu m. However PCBs are slowly eliminated from the

body and the higher chlorinated compounds may accumulate in the body for years. Thus animal experiments that are limited to 2 years by the life span of the animals may not be informative relative to workers exposed for up to 45 years.

In humans, there are no adequate studies to confirm or deny carcinogenicity although preliminary data suggest that among Yusho patients, deaths due to cancers exceed expectations [160,161] and preliminary studies of two occupationally exposed groups in the US indicate that the occurrence of certain cancers may be excessive (HA Sinclair, written communication, June 1976; G Roush, written communication, September 1976). However, the two reports are not consistent as to the types of cancers found to occur more frequently than expected.

(b) Mutagenicity

Several PCBs and PCB mixtures, including the 4- and the 2,2',5,5'-isomers and Aroclors 1221, 1254, and 1260, were subjected to the "Ames" test for mutagenicity [116]. Although 4-chlorobiphenyl had mutagenic activity in this test, the more highly chlorinated PCBs showed very little activity. Aroclor 1254 did not cause significant chromosomal changes in the testes of rats after it was administered for 7 days at 50 mg/kg/day [235]. In another experiment [236], neither Aroclor 1254 administered at 300 mg/kg/day for 5 days nor Aroclor 1242 administered at 500 mg/kg/day for 4 days produced chromosomal aberrations in spermatagonial or bone marrow cells of rats. These mixtures also did not produce any evidence of dominant lethal mutations in rats [237]. Although PCBs have little mutagenic potential, they may alter the mutagenicity and carcinogenicity of other compounds by stimulating microsomal enzyme activities [239].

(c) Teratogenicity

PCBs have been found in embryonic and fetal tissues of humans [139,168] and experimental animals [101] after introduction of PCBs into the maternal body, demonstrating that the potential for direct teratogenic effects exists. Several experiments have been conducted with rats [101,228], rabbits [229], monkeys [232], and dogs and pigs (FL Earl et al, written communication, 1976) that are relevant to a discussion of PCB teratogenicity. In some of these experiments, the PCBs were administered by gavage and doses were reported in mg/kg; in other experiments, the PCBs were reported as ppm fed in the diet. For purposes of relative comparison, 50 ppm in the diet can be equated to 1 mg/kg/day. This is the order of magnitude of the maximum rate of PCB intake by Yusho patients. Animal experiments have used PCBs in dietary-equivalent amounts of 1-2,500 ppm. In most experiments with PCBs administered in amounts equivalent to dietary levels of 100 ppm or more, fetotoxicity (resorptions, abortions) has been such that teratogenic effects may have been masked [101,228,229]. In the two-generation feeding study of rats by Linder et al [228], no terata were reported. This study covered Aroclor 1254 in the concentration range of 1-100 ppm and Aroclor 1260 in the range of 5-100 ppm. Although terata were not reported, Aroclor 1254 concentrations of 20-100 ppm resulted in reduced litter sizes. In rhesus monkeys [232], feeding Aroclor 1248 at 2.5 and 5 ppm caused abortions in some cases and lower than normal birth weights, but no terata were reported. In dogs, terata were not found in pups born from dams fed the equivalent of 12 ppm in the diet, but were present when 48- or 200-ppm equivalents were fed. Sows fed the equivalent of 50 ppm in the same experiment had high rates of resorptions and, at 10-30 times this

level, terata were definitely present in the piglets (FL Earl et al, written communication, 1976).

Although there were retarded intrauterine growth and signs of PCB toxicity in Yusho babies at birth, no terata were reported [149,159,176,182,183]. A normal baby was born to a woman exposed to PCBs in her work. The PCB exposure concentrations were not reported but the PCB concentration in her blood was 25 ppb at the time the baby was born.

These studies indicate that PCBs have teratogenic potential for humans. However, the terata observed in animals occurred at levels at or above doses equivalent to the maximum doses of the Yusho patients and at intake rates 3-4 times greater than intakes expected from inhalation at maximum reported occupational exposures.

b2
(d) Other Effects on Reproduction

Feeding rats Aroclor 1254 at 5 ppm or Aroclor 1260 at 100 ppm had no effects on reproduction over two generations [228]. At higher dietary levels, reproductive effects included poor mating performances, fewer litters, reduced litter size, and high postnatal death rates in the litters. In rabbits, Aroclors 1221 and 1254 were not fetotoxic when administered only during gestation in amounts equivalent to dietary levels of about 50-500 ppm [229]. However, when administered during gestation at higher levels (600-2,500 ppm dietary equivalent), Aroclor 1254 caused resorptions, abortions, maternal death, and, in two fetuses, asymmetric skulls [230]. Delaying administration of PCBs until after the first week of pregnancy did not eliminate the effects.

Feeding rhesus monkeys Aroclor 1248 at 25 ppm for 2 months resulted in a high degree of infertility that persisted for at least 8 months after

the last ingestion of PCBs [232]. In another experiment, rhesus monkeys fed Aroclor 1248 at 2.5 and 5 ppm for 6 months had irregular menstrual cycles with excessive and prolonged bleeding [233]. Even though these monkeys conceived well on mating, resorptions and abortions were frequent, and infertility was common in subsequent matings [233]. Nursing infants developed chloracne-like signs within 2 months and infants frequently died during the nursing period. The milk contained PCBs at 0.154-0.397 ppm [234].

There are no reports of infertility or abortions attributed to human PCB consumption or exposure. There are reports of undesirable effects in children born to mothers exposed to PCBs in the diet and of undesirable effects developing from nursing such mothers.

Babies born from mothers with Yusho were often dark colored and developed signs of Yusho after nursing [176,182,183]. In at least one case, Yusho developed in a baby who was only exposed to PCBs by nursing [182]. Concentrations of PCBs in milk were not determined at the time of the Yusho poisoning. A milk sample obtained after birth of a normal baby from a woman exposed to PCBs at work contained PCBs at 0.25 ppm, and nursing was discontinued [195]. The woman's exposure history and time of last exposure were not given, but PCBs were present in her blood at 24 ppb. Based on the findings in monkeys [234] the decision to not nurse the baby seems entirely justified.

TABLE III-9

EFFECTS OF PCBs ON HUMANS

<u>PCB Intake</u>		<u>Exposure Index</u>		Effects	Ref.
Source	Duration	Environmental, Amount/kind	Blood (ppb)		
Ingestion	Up to 8 mon	0.3-4g Kanechlor 400	>50	Yusho	145- 185
Occupational	Not known	10 mg/cu m	-	Unbearable irritation	130
"	4-8 mon	5-7 mg/cu m Aroclor 1254	-	Chloracne, no liver injury	186
"	2.5-4 mon	Not reported	-	Chloracne, hyperpig- mentation	187
"	<1-20 yr	0.2-1.6 mg/cu m Kanechlors	370, ave.	Chloracne, hyperpig- mentation, liver injury	191
"	2.5 yr ave.	Not reported Kanechlors	820, ave.	Chloracne, no liver injury	194
"	Not reported	>0.25 mg/cu m Not reported	130-520	Chloracne, liver injury	195
"	2.5-18 yr	0.013-0.27 mg/cu m Not reported	36-286	Irritation, liver injury	197
"	14 mon ave.	0.1 mg/cu m Not reported	-	Chloracne, liver injury	190
"	"	Not reported refuse workers	<1-14	No effects	199

TABLE III-9 (CONTINUED)

EFFECTS OF PCBs ON HUMANS

<u>PCB Intake</u>		<u>Exposure Index</u>		Effects	Ref.
Source	Duration	Environmental, Amount/kind	Blood (ppb)		
Occupational	2-23 yr	0.32-1.44 mg/cu m Aroclor 1242	>200	Chloracne, liver injury	196
"	1-23 yr	0.32-1.44 mg/cu m Aroclor 1242	<200	No effects	196
"	Up to 15 yr	Not reported Kanechlors	7-300	Chloracne, elevated triglycerides	192, 193
"	Not reported	Not reported Kanechlors	24 10-100	Normal baby Mild chlor- acne	195
"	4 years	(>1 mg/cu m) Aroclor 1242	74-1,900	No effects	198
General environment	Continuous	Air, 1-100 Food, 10-20 µg/d	>1-30	No effects	137- 141

TABLE III-10.
EFFECTS OF PCB INHALATION ON ANIMALS

Exposure Conditions		Duration	Species	Effects	Ref.
Material	mg/cu m				
Pydraul A 200	30,000	2 hr	Rats	PCB in liver, 70 ppm	97
Solvol	10,000	3 hr	"	100% mortality, liver necrosis	202
"	250-500	8-69 3-hr exposures	"	Liver necrosis, hyper- plasia of Kupffer cells	202
Decachloro- diphenyl	2,500	6 hr	"	Irritation, no gross effects	98
"	800	6 hr/d, 5 d/wk, 4 wk	"	Irritation, increased liver weights, micro- scopic liver changes blood cell changes	99
"	4 and 80	"	"	No irritation, increased liver weights in females	99
Aroclor 1242	8.6	7 hr/d, 5 d/wk, 3 wk	Mouse, rat, cat, guinea pig, rabbit	None	203
"	6.8	7 hr/d, 5 d/wk, 17 wk	"	"	203
"	1.9	7 hr/d, 5 d/wk, 31 wk	"	"	203
Aroclor 1254	5.4	7 hr/d, 5 d/wk, 17 wk	"	Microscopic liver changes	203
"	1.5	7 hr/d, 5 d/wk, 31 wk	"	Microscopic liver changes: reversible	203

IV. ENVIRONMENTAL DATA AND BIOLOGIC EVALUATION

Environmental Concentrations

Two reports of workroom air concentrations of PCBs appeared in 1954 [186,190]. Puccinelli [186] studied the concentrations in air of a capacitor factory in Italy, using the methods of Elkins [130], and found concentrations in 500-liter air samples of 5.2-6.4 mg/cu m. Miegs et al [190] did not report on the analytical methods they used to determine concentrations of PCBs in the breathing zones of workers exposed when a heat exchange unit in a Connecticut factory leaked. From the description of the factory, it is likely that the exposures were largely to vapors; the concentration found was 0.1 mg/cu m.

In 1959, Elkins [130] reported that over a number of years, PCBs in some Massachusetts plants ranged up to 10.5 mg/cu m of air (Table IV-1).

TABLE IV-1

PCB CONCENTRATIONS MEASURED IN MASSACHUSETTS FACTORIES

Process	PCB Concentrations (mg/cu m)	
	Maximum	Average
Capacitor impregnating	10.5	5.8
"	5.5	4.5
"	0.3	0.2
Capacitor soldering	0.9	0.8
Oil mixing	1.1	0.6
Regulator filling	0.2	0.1

Adapted from reference 130

Of 21 air samples collected in capacitor impregnating operations, Elkins considered that hazardous concentrations (>1 ppm for Aroclor 1242; >0.5 ppm for Aroclor 1254) existed in 15. While the sampling and analytical methods used were not documented, Elkins [130] recommended sampling with either a fritted bubbler or two impingers in series, both containing amyl acetate, and analyzing by the sulfur lamp method.

Occupational environmental studies were conducted in five Japanese plants by Hasegawa et al [191]. Kanechlors 200 (predominantly dichlorobiphenyls), 300 (mostly trichlorobiphenyls), and 400 (mostly tetrachlorobiphenyls) were used or manufactured in the plants. Air samples were drawn through filter paper to collect particulate matter and normal hexane to collect vapors and analyzed by GLC. The data are summarized in Table III-7. In the paired samples, the vapor concentrations exceeded the particulate concentrations. One of the plants was a biphenyl recovery plant where PCBs were not used. In this plant, PCB concentrations were <0.02 mg/cu m. In the PCB manufacturing plant, PCB vapor concentrations were 0.026-0.163 mg/cu m, and particulate PCB concentrations were 0.019-0.037 mg/cu m. Higher PCB concentrations were found in the capacitor plants: 0.095-0.965 mg/cu m of vapors, and 0.20-0.65 mg/cu m of particulates. In one particulate sample collected in a capacitor plant after a spill, the PCB concentration was 6.2 mg/cu m.

Staiff et al [243] in a 1974 report were concerned about emissions from burned-out PCB-containing ballasts in fluorescent fixtures in their laboratory. The investigators collected samples in two midget impingers, containing ethylene glycol and connected in series. The samples were analyzed by GLC. PCB concentrations in the air ranged from 0.012 to 0.166

mg/cu m when the ballasts burned out and were 0.002 mg/cu m 3 days later.

In a 1976 report of a survey of Australian workers exposed to Aroclor 1242, Ouw et al [196] listed breathing zone concentrations ranging from 0.32 to 2.22 mg/cu m before corrective measures were taken, and from 0.08 to 0.75 mg/cu m after installing improved ventilation. Breathing zone samples were collected at 30 liters/minute using Greenburg-Smith impingers containing 75 ml of isopropanol. The concentrations found are shown in Table IV-2.

TABLE IV-2

PCB CONCENTRATIONS IN THE AIR INSIDE A CAPACITOR PLANT BEFORE
AND AFTER IMPROVEMENT OF EXHAUST VENTILATION SYSTEM

Areas in the Impregnation Room	PCB Concentrations mg/cu m	
	Before	After
Area in the unloading tank in front of exhaust register from operator's breathing zone	1.44	0.75
Area in the unloading tank not in front of exhaust register	2.22	0.7
General atmosphere near tank	1.08	0.18
Soldering area	0.32	0.08

Adapted from reference 196

Exposures of electrical and materials technicians during 1976 to PCBs contained in materials they tested were evaluated by Levy et al [197]. Air samples were collected on magnesium silicate "Florisil" at 50 ml/minute for

25
38-10000
AUG 01 '77

4-8 hours and analyzed by GLC utilizing electron capture detection. Breathing zone samples were collected on a single day from nine employees for 8 hours. The concentrations in the nine breathing zone samples, which would represent TWA exposure concentrations for the day, ranged from 0.014 to 0.073 mg/cu m. Concentrations of PCBs in nine point source samples collected over 4-8 hours on each of 3 days ranged from 0.013 to 0.264 mg/cu m, and in 19 room air samples collected over 4 hours on each of 3 days, from 0.08 to 0.16 mg/cu m.

A plant manufacturing PCBs in the US was surveyed for worker exposure in July 1976 [244]. Three Aroclors (1016, 1242, and 1254) were made in the PCB production area. To begin the process, biphenyl and chlorine were piped into a chlorinator with a catalyst and allowed to react. Two separate groups of chlorinators were used for Aroclors 1242 and 1254. The product resulting from the reaction passed through a purifying operation, or to a distillation column as in the case of converting Aroclor 1242 to Aroclor 1016, and then on to the storage tanks. Mixing tanks were used to give the desired properties to the final product.

Although the operation was outdoors and theoretically a closed system, potential for employee exposure existed when samples were drawn or leaks occurred. Local exhaust ventilation was used in two operations: (1) while filling 55-gallon drums, hoses were placed near the openings, and (2) when employees tested samples drawn from the chlorinators, their work station was equipped with an exhaust fan and hood.

Eleven personal and seven area air samples were taken in the PCB production area for 6-8 hours at a flow rate of 200 cc/minute [244]. PCBs were collected on Florisil, desorbed with hexane, and analyzed by GLC with

EC detection. Aroclor 1016 was the PCB produced on the sampling dates, and it was used as the standard for quantitating airborne PCBs. Personal air sample concentrations of PCBs reported as Aroclor 1016 ranged from 20 to 86 $\mu\text{g}/\text{cu m}$, while PCBs in area samples ranged from 16 to 55 $\mu\text{g}/\text{cu m}$. The data are presented in Table IV-3.

TABLE IV-3

PCB CONCENTRATIONS FOUND IN A PLANT MANUFACTURING PCBs
ON 2 CONSECUTIVE DAYS ($\mu\text{g}/\text{cu m}$)*

<u>Personal Air Samples</u>		
Job Title	7/21/76	7/22/76
Premium operator	47	20
Second operator	46	43
Column operator	64	51
Still operator	40	86
Standard operator	-	61
Distribution operator	54	36
<u>Area Air Samples</u>		
Location	7/21/76	2/22/76
Drumming	43	51
Temperature testing	25	52
Chlorinators	55	36
Incinerator burner	16	-

*Total sampling time varied from 409 to 455 minutes and sample volumes varied from 67.6 to 201.6 liters.

Adapted from reference 244

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Sato and Hasegawa [32] studied concentrations of PCBs in factories that had discontinued their use in production of pressure-sensitive copying paper 2 years earlier. PCB concentrations in the factories had not been determined when PCBs were being used, but were considered [3] to have been similar to those found by Hasagawa et al [196] in capacitor manufacturing plants. The concentrations found by Sato and Haswgawa [32] at the time of sampling ranged from 0.13 to 4.4 $\mu\text{g}/\text{cu m}$. The PCB concentrations in the outdoor air around the factories were 0.043-0.09 $\mu\text{g}/\text{cu m}$ [3].

Another study of contamination in factories after PCB use had been discontinued was reported by Fujiwara et al [33]. These investigators found 0.25 $\text{mg}/\text{cu m}$ in air of a factory that had previously used PCBs in silk glossing. In addition to air contamination, PCBs were found in the dust around machinery and in the floor boards.

PCB concentrations found in the air of some other factories and their surrounding environments in Japan were summarized in 1976 by Tatsukawa [245]. Concentrations found before 1957 in a factory producing transformers and capacitors ranged from 0.39 to 4.5 $\text{mg}/\text{cu m}$. The factory was said to have been old-fashioned with bad ventilation [245]. Concentrations found in warehouses for carbonless copying paper in 1972 ranged from 2 to 70 $\mu\text{g}/\text{cu m}$. In the same year, concentrations of 0.04-0.05 $\mu\text{g}/\text{cu m}$ were found in a university laboratory where PCBs were used, and concentrations of 0.006-0.12 $\mu\text{g}/\text{cu m}$ were found in areas of mills that recycled paper. Background concentrations found in urban areas of Tokyo, Osaka, and Matsuyama City were <0.002-0.04 $\mu\text{g}/\text{cu m}$.

Background concentrations of PCBs in ambient air over the US have been reported in $\text{ng}/\text{cu m}$ quantities [26,38]. Average concentrations of

about 100 ng/cu m were found in Florida and Colorado in 1975 [38].

Control of Exposure

The present primary use of PCBs is as dielectric or insulating fluids for electrical capacitors and transformers. Potential hazards of PCBs in these industries result from inhalation and dermal exposures. It is here that engineering controls, such as local exhaust systems, are necessary.

Local exhaust systems should be designed and operated in conformance with American National Standard Z9.2-1971 Fundamentals Governing the Design and Operation of Local Exhaust Systems [246]. Guidelines for handling capacitor and transformer askarels include the following recommendations from the American National Standards Institute (ANSI) [4]: (1) Enclosed systems of sealed piping, properly gasketed joints, valves, containers, and processing chambers should be used for any portion of the operation where askarel temperatures may exceed 55 C; (2) Enclosure should preferably extend to all other portions of the system insofar as practicable; (3) Operations utilizing PCBs should be isolated from other manufacturing areas to avoid cross contamination; (4) Provision should be made for adequate ventilation and regulation of manufacturing operations to avoid open exposure to askarels; (5) When askarels are used at elevated temperatures (especially 55 C or higher), engineering controls must be applied, either by the use of closed systems or by effective local exhaust ventilation with general workroom exhaust.

Durfee et al [247] cited the following potential sources of air emissions of PCBs in transformer and capacitor manufacturing operations:

(1) vapor exhaust from stream jet ejectors; (2) evaporation from accidental

spills; (3) evaporation from hot surfaces as part of flood-filling, inspection, or holding operations; (4) vacuum pump exhausts; (5) evaporation from plant waste water.

There are currently no commercially available fluids which can be considered as totally acceptable substitutes for PCBs in the broad range of AC capacitors, nor are there substitute dielectric systems which would satisfy reliability and safety requirements in most applications [28]. Transformers containing PCBs represent only about 5% of the US transformer market, and are used only where safety and reliability are of prime importance. For new installations, building and installation design provisions could be made to accommodate the use of filled, open dry-type, or sealed dry-type transformers. Major construction changes would be required to compensate for the fire resistance of askarel-filled units if existing askarel-filled transformers are to be replaced with oil-filled units of equivalent electrical ratings [4].

Environmental Sampling and Analytical Methods

(a) Air Sampling

Before discussing the various methods available for sampling airborne PCBs, it is pertinent to discuss the criteria for an ideal sampling device. NIOSH evaluated an industrial worker's exposure and found that sampling in the breathing zone gives a truer picture of actual exposure than does area sampling. The first criterion for an ideal air sampling device then is that it be amenable to personal sampling. In addition, it should be light, compact, and small enough so that workers can pursue their daily activities without being aware of its presence. The second criterion is that the

sampling device have a sufficient capacity for PCBs to enable the collection of an air sample representative of a typical workday. Thirdly, recovery of PCBs from the sampling device should be quantitative or, at the least, reproducible. Finally, the sample must be stable in or on the sampling device between the time of sampling and the time of analysis. This latter criterion is hardly of concern here due to the general stability of PCBs.

An air sampling procedure using fritted bubblers or impingers filled with toluene was published by ANSI in 1974 [4]. Neither the sampler capacity nor the sampling efficiency had been experimentally evaluated. Where high sampling flow rates or high capacities were required, additional bubblers or impingers in series were recommended.

Bidleman and Olney [248] used porous polyurethane foam for collecting samples of atmospheric PCBs. They found that the polyurethane foam showed excellent collection efficiency (99% or better) for tri-, tetra-, and pentachlorobiphenyls. The authors [248] did not address the matter of sample recovery from the sorbent.

In an environment where carbonless copy paper was being used, Nishiyama et al [249] collected PCBs by drawing the air through a cooled column filled with Shimalite, a gas chromatographic solid support similar to Chromosorb W. The collection efficiency of the device was 95% and the PCBs were eluted from the column with hexane. Other investigators used 5% glycerol-coated Florisil for collecting organochlorine pesticides and PCBs from air [250]. Collection efficiencies were 90-100% for PCBs.

Harvey and Steinhauer [251] collected ambient air samples of PCBs using 0.25% OV-17 silicone oil coated on ceramic saddles (distillation

column packing). The collection efficiency of this device was 70%. More recently, Giam et al [252] found that sorbent tubes packed with deactivated Florisil could be used for collecting PCBs and phthalates from air [252]. These compounds were found to be effectively retained by Florisil. The authors did not discuss efficiency of recovery.

In 1976, Laveskog and Lindskog [253] described a stack sampling device for chlorinated hydrocarbons which they used for PCB collection. This device utilized glass wool for the collection of particulates followed by a sorbent, 25-40% Apiezon M on Chromosorb W, to collect vapors. The collection efficiency of the column was 99%, and desorption efficiency with absolute ethanol was 87%. The authors investigated charcoal as a sorbent, but found it unsuitable for their purposes since the PCBs could only be recovered by extraction in a soxhlet apparatus with chloroform which in turn could not be used with electron capture detection.

Occupational Safety and Health Administration (OSHA) workers have used charcoal tubes for personal air sampling for PCBs (RG Kupel, written communication, 1976). While the sampling device would be expected to have good capacity for PCBs, recovery from charcoal is not quantitative. Little other information is known about this method.

A NIOSH Standards Completion Program Report [254] indicated that PCBs with 54% chlorine content were effectively trapped on a fibrous glass filter. However, the presence of PCB vapor either apparently was not addressed or was assumed to be negligible. This may not be a valid assumption, particularly since another report from the same program [255] showed that PCBs with 42% chlorine content have appreciable vapor pressure.

NIOSH has also investigated the method of Giam et al [252], using Florisil as a sampling medium, in industrial environments. Florisil (30/48 mesh) was placed in a tube similar to that used in the charcoal tube method for solvents, 100 mg in the front section and 50 mg in the back. The retention capacity of this sampling device for PCBs was evaluated under laboratory and field conditions, using various vapor generation techniques. In laboratory experiments, PCBs at 10 $\mu\text{g/liter}$ and 75% relative humidity were sampled through a 100-mg Florisil bed at 0.2 liter/minute with no evidence of breakthrough after 4 hours (48 liters). Of 21 samples collected on Florisil in a capacitor plant, only 6 had PCBs on the backup section and all 6 backup sections contained 1% or less of the total PCBs in the tube. The volumes of air sampled ranged up to 61 liters, and PCB concentrations in air as high as 1.5 $\mu\text{g/liter}$ were measured. Other laboratory experiments showed that PCBs could be desorbed quantitatively from Florisil with hexane. Results from Florisil tube and impinger samples taken side by side in the capacitor plant and analyzed with a single commercial PCB product as a standard were statistically similar.

Impingers are not suitable for personal sampling and are inconvenient to use because they must be recharged with the sampling solvent frequently and must be used in series. The handling of absorber solutions is difficult because of the potential for spillage and leakage of the solvent and samples during transport to and from the sampling site. Solid sorbent sampling devices are well suited for personal sampling since they are relatively small, and personnel wearing the devices quickly become unaware of their presence, enabling more representative sampling. Shipment of these devices is relatively simple.

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Of the solid sorbent sampling devices discussed, Florisil-filled tubes are deemed the most advantageous because Florisil has a high capacity for PCBs and can be quantitatively desorbed; field evaluations have shown that Florisil-filled tubes are easier to handle and more convenient than impingers. Therefore, the Florisil-filled tube method is recommended for collection of PCBs from air, as detailed in Appendix I.

(b) Analytical

The chemistry of PCBs was extensively reviewed by Hutzinger et al [1], and PCB analytical chemistry has been reviewed by several authors [256-264] but only references pertinent to selection of an analytical method for determination of PCBs in industrial air samples will be discussed here. Of the analytical techniques available, the one most widely used for determining PCBs is GLC with EC detection. This technique is rapid, precise, and very sensitive. The far greater sensitivity of EC detection compared with that of the flame ionization detector (FID) is demonstrated by comparison of their relative responses to various PCB isomers, shown in Table IV-4 [1].

TABLE IV-4

RELATIVE MOLAR RESPONSES OF ELECTRON-CAPTURE AND FLAME-IONIZATION
DETECTORS TO SOME PCBs

PCB	Relative Molar Response	
	Electron Capture	Flame Ionization
2-chloro	1.00	1.00
3-chloro	0.20	0.92
4-chloro	1.10	0.87
2,2'-dichloro	5.16	0.99
2,4-dichloro	17.7	0.86
2,6-dichloro	32.0	0.91
3,3'-dichloro	6.10	0.94
3,4-dichloro	15.2	0.86
4,4'-dichloro	5.97	0.81
2,4,4'-trichloro	135	0.78
2,2',4,4'-tetrachloro	106	0.87
2,2',6,6'-tetrachloro	20.6	0.90
3,3',4,4'-tetrachloro	396	0.87
3,3',5,5'-tetrachloro	320	0.85
2,3,4,5-tetrachloro	367	0.87
2,3,5,6-tetrachloro	259	0.71
2,2',4,4',6,6'-hexachloro	347	
3,3',4,4',5,5'-hexachloro	726	
2,2',3,4',5,5',6,6'-octachloro	1,180	
2,2',3,3',5,5',6,6'-octachloro	1,150	
decachloro	1,410	

Adapted from reference 1

During the GLC-EC detection analysis of PCBs, multicomponent mixtures of various PCBs are almost always encountered. The samples analyzed may or may not resemble a commercial PCB mixture. If so, the appropriate commercial PCB mixture can be used as a standard for quantitation; if not, a commercial mixture should not be used. Quantitation cannot be accurate since it is based on incomplete resolution of PCB isomers. Even if complete resolution were possible, all PCB isomers are not available for standards and the specific EC detection response of each isomer would need

to be known.

Many different methods have been used to "quantitate" or estimate PCBs. Heights or areas of one [263], two [264], three [265], or more [266,267], or of all chromatographic peaks [268-270] of a given sample have been used for comparison with standard commercial PCB mixtures. The chief disadvantage of such methods is that when the chromatogram of the sample does not closely resemble that of the standard the estimates are neither precise nor accurate. An improvement upon these methods is the use of mixed PCB standards, as described by Beezhold and Stout [271]. This procedure involves mixing various proportions of different PCB commercial mixtures, such as Aroclor 1242 and Aroclor 1254, and obtaining sets of chromatograms. The chromatogram most closely resembling the sample is selected and the corresponding mixture is used as the standard.

Sawyer [269], in a collaborative study, evaluated the quantitation of PCBs in chicken fat. He found that the use of the total peak area or the sum total of all peak heights gave better results than did the use of selected peaks. The use of mixed standards gave good results when the composition which best duplicated the response pattern of the sample was used. This was adopted as an official method by the Association of Official Analytical Chemists [272].

Using a different approach to standardization, Rote and Murphy [273] produced a standard response curve using Aroclors 1232, 1242, 1248, 1254, 1260, and 1262. This plot was of the total area responses on the GLC trace divided by the weights of the Aroclors injected versus the average number of chlorine atoms in the molecule. The peaks in each chromatogram were identified as to chlorine content per chlorobiphenyl molecule, and

each sample could then be quantitated using the response curve. The accuracy of this method is not greater than that of the methods previously mentioned, since it has been shown that the response of EC detection varies greatly with the degree of chlorine substitution and also with the relative position of the chlorine substitution [1].

Risebrough et al [274] and Collins et al [268] used dichlorodiphenyl-dichloroethylene (p,p'-DDE) as a standard and assumed that the response of each chlorobiphenyl isomer was equal to that of p,p'-DDE. This method can only be grossly approximate, since the response of EC detection to individual PCB isomers varies greatly [1].

Risebrough et al [274] also reported the use of microcoulometric detection to determine total chlorine content, using a commercial PCB mixture as a standard. Sawyer [269] compared the EC detection with the microcoulometric and electrolytic conductivity detectors and found that the latter two detectors are subject to more operational problems than is the EC detection.

An analytical method utilizing a computer for the quantitation of PCBs was described by Zobel [273]. This method would not be of value for routine sample analysis in industrial hygiene laboratories because of the expense or unavailability of a computer.

The method of Webb and McCall [276] involves standardization of an Aroclor mixture whose peak-by-peak composition has been determined as weight percentages of the total. Since the response-to-weight factor is known for each peak, the actual weight equivalent of each peak in the sample can be calculated despite vast differences of overall GLC patterns. To utilize this method as a standard procedure, it is necessary that some

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agency serve as a central repository for distribution of the reference materials. Presently, standards for Aroclors 1242, 1254, and 1260 as dilute solutions in iso-octane are available from Webb and McCall [276]. However, a fully characterized standard for the widely used Aroclor 1016 is not available. Potential future sources for these types of standards may be either the Association of Official Analytical Chemists or the US Food and Drug Administration. These organizations currently are interested in this method [277] and are planning to test it collaboratively.

The US Environmental Protection Agency has adopted the method of Webb and McCall [276] as a recommended procedure for quantitation of PCBs in industrial effluents [278]. Other investigators have also concluded that this method is the best available method of quantitation [279].

Berg et al [280] investigated the quantitation of PCBs in terms of derivatives. PCBs could be quantitatively converted by catalytic dechlorination to bicyclohexyl. However the authors [280] found that the relatively low level of sensitivity, because bicyclohexyl had to be determined by GLC with FID, was a marked disadvantage. They [280] found that treatment of PCBs with antimony pentachloride under elevated temperatures and anhydrous conditions gave good yields (85%) of decachlorobiphenyl which could be determined by GLC with EC detection.

Armour [281] evaluated the perchlorination procedure of Berg et al [280] to determine its utility as a routine method for the confirmatory quantitation of PCBs. It was found necessary to modify that procedure because of observed inconsistencies in the efficiency of conversion of Aroclors 1254 (90-100%) and 1242 (30-70%) to decachlorobiphenyl. Armour [281] attributed this to volatilization of the lower molecular weight PCB

components during solvent evaporation before their reaction with antimony pentachloride. The remedy selected was to end evaporation while a small amount (0.1 ml) of solvent still remained, but this rendered the choice of solvents a more critical matter because of possible interferences during the perchlorination step. Chloroform was the solvent chosen because it minimized volatility and reacted favorably at the selected conditions. The increased pressure produced as a result of this substitution of chloroform required discontinuing use of flame-sealed Carius tubes as recommended by Berg et al [280] for containing the elevated temperature-pressure perchlorination reaction. The recommended substitute was a vacuum hydrolysis tube having the same volume specifications (10 mm O.D. X 150 mm), a tight Teflon sealing valve, and a side venting arm [281].

Other modifications devised by Armour [281] included the addition of methanol to the reaction mixture's extract to produce an azeotrope with the residual chloroform which could then be evaporated to a small volume before dilution, preparatory to determination of decachlorobiphenyl. To determine the feasibility of a shortened reaction time, Armour et al tested iron as a catalyst, but decided that although a reaction time of 6 hours with iron catalyst resulted in quantitative (99% average conversion for six Aroclors) and reproducible (83-110%) conversions, the catalytic modification offered little advantage over the overnight procedure.

Perchlorination has been used for the quantitation of PCBs by others [282,283]. While the sole perchlorination product was usually decachlorobiphenyl, there have been reports of undesired byproducts resulting from contamination of the antimony pentachloride with bromide ions [284,285]. Results of NIOSH investigations indicate that this

contamination problem can be eliminated by vacuum distillation of the antimony pentachloride. Factors for converting decachlorobiphenyl to Aroclors are presented in Table IV-5.

TABLE IV-5

FACTORS TO CONVERT DECACHLOROBIPHENYL TO AN EQUIVALENT AMOUNT OF AROCLOR

Aroclor	Average Molecular Weight	Q*
1221	188.5	0.38
1232	223	0.45
1242	257.5	0.52
1016	257.5	0.52
1248	292	0.59
1254	326.4	0.65
1260	361	0.72
1262	395.3	0.79

*Calculated by dividing the average molecular weight by 499, the molecular weight of decachlorobiphenyl

Adapted from reference 281

From a review of the literature, NIOSH concludes that the simplest method of PCB quantitation involves standardization of samples with single commercial mixtures of PCBs. Should the composition of a sample not closely resemble that of a single commercial PCB mixture, the most accurate and precise method of quantitation available would be that of

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perchlorination, which, seems to offer the best approach for determining total PCB content in samples when the initial concentrations of individual PCBs are of little or no concern.

NIOSH recommends desorption of PCBs from Florisil with hexane, analysis by GLC, and quantitation of the sample by comparison with a standard PCB mixture of similar composition (Appendix II). If a PCB mixture with a composition similar to that of the sample is not available as a standard, NIOSH recommends converting the sample PCBs to decachlorobiphenyl for quantitation.

The methodology presented in Appendices I and II has been tested with Aroclor 1016 in the laboratory and in practice. Operating parameters found by NIOSH are presented in the Appendices.

Biologic Evaluation

While there is presently no adequate method for biologically monitoring industrial workers for exposure to PCBs, additional research may make feasible the routine measurement of residues of these compounds in blood or other body fluids.

ANNEX 53

V. WORK PRACTICES

The employment of good work practices is required if hazardous occupational exposures to PCBs are to be prevented. The carcinogenic, teratogenic, dermatologic, and fetotoxic effects of PCBs largely determine the nature of necessary work practices.

(a) All locations where occupational exposure to PCBs occurs should be established as regulated areas and posted with signs warning persons of the procedures necessary upon entering or leaving.

When an otherwise closed PCB system is opened, eg, during the loading and unloading of storage tanks, the following work practices are desirable:

- (1) Only authorized personnel should be permitted in the area;
- (2) Adequate ventilation should be provided and the exhaust air should not be discharged into any environment until it has been adequately decontaminated;
- (3) To prevent skin contact with PCBs, workers should be required to wear and use PCB-resistant protective clothing and equipment, including respirators.
- (4) Upon leaving regulated areas, workers should be required to remove such protective clothing and equipment and place it in impervious containers pending either decontamination or disposal;
- (5) After removing such protective clothing and equipment, workers should be required to wash their hands, forearms, and faces, and to shower after the last exposure of the day.

Whenever a worker must come into direct contact with PCBs, eg, during cleanup of spills or maintenance of vessels, PCB-resistant protective clothing and an appropriate respirator must be worn.

(b) Leakage and Spill Procedures

PCB spills are to be cleaned up promptly, either by the use of sorbent materials, such as sawdust, or by trapping and removal through pumping or other suitable means. In case of spill of PCBs on clothing, the contaminated clothing should be removed as soon as practical, the skin should be thoroughly washed, and the clothing should be laundered or disposed of properly. Facilities and procedures for such cleanup must be provided at manufacturing facilities producing capacitors and transformers, because spills of PCBs are quite likely to occur during the filling and handling of such devices. Users of PCB-filled transformers should inspect them periodically for leakage. If leakage is found, the cause should be corrected and the spillage should be soaked up with sawdust or other absorbent material. The leak area should be cleaned finally with rags soaked with an appropriate safe solvent. Leaky transformer gaskets can be sealed temporarily by painting over the leaky area with epoxy cement. Refer to Transformer Askarel Inspection and Maintenance Guide [25], and Guidelines for Handling and Disposal of Capacitor and Transformer Grade Askarels Containing Polychlorinated Biphenyls [4] for further maintenance procedures.

(c) Emergencies

In emergencies, immediate measures must be taken to eliminate hazardous conditions. Non-essential workers must be evacuated until the emergency no longer exists. Any worker having visible contamination of the

skin with PCBs must shower immediately unless other action is warranted.

(d) Respiratory Protection

To ensure against inadvertent exposure to PCBs, workers' respirators must be properly selected, fitted, and maintained. A guide to industrial respiratory protection [286] has been developed which contains sufficient information to enable the establishment and maintenance of a respirator program that meets the requirements outlined in 29 CFR 1910.134. The guide [286] includes information on respirator selection, use, maintenance, and inspection, as well as a complete description of various types of respirators and their advantages and limitations, respirator fitting procedures, wearer training instructions, and physiologic and psychologic constraints on respirator use.

Several NIOSH studies [287-289] have shown that respiratory protection may be inadequate in many occupational situations, eg, abrasive blasting, coal mining, and paint spraying. For this reason, respirators are generally regarded by NIOSH as a type of control to be used only where engineering controls cannot be used, made adequate, or provided.

VI. DEVELOPMENT OF STANDARD

Basis for Previous Standards

In 1942, the Subcommittee on Threshold Limits of the National Conference of Governmental Industrial Hygienists compiled a list of maximum permissible concentrations of atmospheric contaminants recommended by various state industrial hygiene units [290]. The eight states that made recommendations for PCBs (chlorodiphenyls) were unanimous in recommending 1 mg/cu m. No basis for the recommendations was given.

Cook [291], in his 1945 listing of Maximum Allowable Concentrations of Industrial Atmospheric Contaminants, cited PCB standards for California and Utah of 1 mg/cu m and Oregon of 0.3 mg/cu m. He [291] also cited unofficial guidelines for Massachusetts of 5 mg/cu m and for New York of 1 mg/cu m and he recommended 1 mg/cu m, based on the report of Drinker [132].

The American Conference of Governmental Industrial Hygienists (ACGIH) began listing PCBs (chloro di phenyl) with "toxic dusts, fumes and mists" in its recommendations of maximum allowable concentrations of air contaminants for 1946 [292]. It compiled its 1946 list from its 1942 list [290] and from Cook's [291] list, and continued to recommend 1 mg/cu m for PCBs.

The ACGIH continued to recommend 1 mg/cu m for PCBs (chlorodiphenyl) until 1954 when it specified 1 mg/cu m as the limit for PCBs with 42% chlorine and proposed a limit of 0.5 mg/cu m for PCBs with 54% chlorine [293]. Each recommendation was clearly defined as a threshold limit value (TLV) for an 8-hour TWA concentration to which it was "felt" workers could be repeatedly exposed without adverse effect on their health.

In 1961, the ACGIH added the notation "skin" to the TLV of those substances, including PCBs, which in liquid form can penetrate the skin to cause systemic effects [294,295].

In 1962, the ACGIH published documentation of its TLV recommendations [296]. Based on information in the reports of Schwartz [123], Drinker et al [125], Meigs et al [190], and Treon et al [203], the ACGIH [296] concluded that for PCBs chlorinated to 42%, 1 mg/cu m would seem to offer reasonably good protection against severe systemic toxicity but may not guarantee complete freedom from chloracne. They also cited the information [207] that PCBs could be absorbed through the skin, causing fatty degeneration of the liver. In documenting its recommendation for PCBs containing 54% chlorine, the ACGIH [296] cited Drinker et al [125], Drinker [132], and Treon et al [203], and on the basis of these reports it [296] considered that 0.5 mg/cu m appeared to be reasonable for repeated occupational exposures.

The American Industrial Hygiene Association's Hygienic Guide "Chlorodiphenyls (containing 42% and 54% chlorine)" [297], published in 1965, adopted the ACGIH recommendations for time-weighted average exposures and suggested a short-exposure tolerance for PCBs of 10 mg/cu m to prevent unbearable irritation, based on the report of Elkins [130]. The Hygienic Guide [297] provided information that minimum lethal doses applied to the skin of rabbits for 24 hours were 1 g/kg for PCBs containing 42% and 1.5 g/kg for PCBs containing 54% chlorine. It also recommended avoiding prolonged or repeated skin contact, and it recommended laundering of contaminated clothing before reuse, protecting the eyes from liquid splashes, treatment of the eyes if PCBs were splashed into them, and

periodic examinations to detect early evidence of skin irritation or liver damage.

In 1970, the International Labour Office published permissible levels of toxic substances for several nations [298]. The PCB standards for six nations are given in Table VI-1.

TABLE VI-1

PERMISSIBLE LEVELS OF PCBs FOR SIX NATIONS

Country	Standard (mg/cu m)	Type of Standard
Czechoslovakia		
42% Chlorine	1.0	MAC
54% Chlorine	0.5	"
Finland		
42% Chlorine	1.0	MAC 8-hour
54% Chlorine	0.5	"
Poland	0.1	MAC
Romania		
42% Chlorine	1.0	"
54% Chlorine	0.5	"
USSR	1.0	"
Yugoslavia		
42% Chlorine	0.5	"
54% Chlorine	0.5	"

Adapted from reference 298

In 1973, Winall [299] compiled a list of international occupational hygienic standards for chemicals, including "chlorodiphenyl." She listed values for Sweden of 0.5 mg/cu m and for the German Democratic Republic of 1.0 mg/cu m. In both countries the standards were the same for PCBs containing 42% and 54% chlorine. The standards listed for the Federal Republic of Germany were 1.0 mg/cu m for PCBs containing 42% chlorine and

0.5 mg/cu m for those with 54% chlorine, respectively.

The TLV documentations for PCBs published by the ACGIH in 1976 [300] did not differ significantly from the original documentations [296]. However, the ACGIH [300] recalled, citing von Wedel et al [205], that several deaths due to liver atrophy occurred among workers exposed to fumes of chlorobiphenyls and chloronaphthalenes, but pointed out that relatively few, if any reports had appeared of systemic poisoning of workers exposed only to fumes of PCBs.

The ACGIH has retained a TWA of 1 mg/cu m as the TLV for PCBs with 42% chlorine content and a TWA of 0.5 mg/cu m as the TLV for those with 54% chlorine content (through 1976) [301]. However, a tentative short-term exposure limit (TLV-STEL) was added to the recommendations in 1976. STEL is defined by ACGIH [299] as the maximum concentration to which workers can be exposed for up to 15 minutes continuously without suffering from irritation, chronic or irreversible tissue change, or narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency. According to the ACGIH [301], the STEL is to be considered a maximum allowable concentration, or absolute ceiling not to be exceeded at any time during the 15-minute excursion period; such excursions are not to occur more than 4 times a day and there must be at least 60 minutes between them. The STEL recommended for PCBs was 1 mg/cu m regardless of the degree of chlorination. This recommendation was made on the basis that the TLV documentation for PCBs [300] suggested that the values should be ceilings never to be exceeded, rather than TWA values for 8 hours of exposure [301].

The 1968 ACGIH recommendations [302], adopted as the federal standards for PCBs (29 CFR 1910.1000, Table G-1) are TWA 8-hour exposure concentrations of 1.0 mg/cu m for mixtures containing 42% chlorine and 0.5 mg/cu m for mixtures containing 54% chlorine.

Basis for the Recommended Standard

(a) Permissible Environmental Limit

The major effects that have been found in workers exposed to PCBs are chloracne [186-191,195,196], liver injury [190-193,196], and irritation of skin and mucous membranes [192,196,197]. Exposures at peak PCB concentrations of 5-10 mg/cu m have been reported as "unbearably" irritating [130].

Chloracne has been reported after occupational exposure to Aroclors 1242 [196] and 1254 [186], and to various Kanechlors [191,192,194,195], as well as after ingestion of Kanechlor 400 [146,153]. Chloracne has frequently been associated with processes where the PCBs were heated [186-189,196]. The methodology in most of the exposure studies did not differentiate between vapor and particulate forms of the PCBs [186,190,196]. In one study of Kanechlors in capacitor manufacturing plants where chloracne was common, vapor (or small particulate) concentrations (0.095-0.95 mg/cu m) exceeded particulate concentrations (0.02-0.65 mg/cu m) [191]. In another capacitor plant where heated Aroclor 1254 was used, exposure concentrations were 5-7 mg/cu m, but the vapor components were not separately determined [186]. In this plant, chloracne developed in workers after 4-8 months of exposure. A study of workers, in a plant where the work situation indicated the exposures were to PCB

vapors, showed that chloracne developed after a minimum of 5 months and an average of 14 months of exposure [190]. In this study, exposure concentrations of an undefined PCB were reported as 0.1 mg/cu m. In other studies where PCB concentrations were not measured, chloracne developed after 3-8 months of exposure [187,189].

These data show that chloracne can develop after prolonged exposures to PCBs in concentrations as low as 0.1 mg/cu m, and that as the PCB exposure concentrations increase, the duration of exposure required for the development of chloracne decreases. The data also indicate that PCBs in the vapor phase may contribute substantially to development of chloracne. However, they do not prove that only PCB vapors cause chloracne. Particulate PCBs have been shown to be absorbed from inhaled air by experimental animals [97], and ingested PCBs have caused chloracne [146,153]. Occupational exposure to a variety of PCB mixtures (Aroclors 1242, and 1254, various Kanechlors, and others) has caused chloracne, and no commercial PCB mixture has been shown to have more or less chloracnegenic properties than others.

There are some studies of PCB workers in which chloracne was not found [197-199]. In one of these studies, the Aroclor 1242 concentrations were imprecisely reported [198] and in the others the PCB mixtures were undefined [199]. The report by Levy et al [197] gave possible PCB exposure concentrations of 0.013-0.264 mg/cu m and breathing zone concentrations of 0.014-0.073 mg/cu m. Thus the data indicate that chloracne may be prevented by keeping PCB exposures below 0.1 mg/cu m (100 µg/cu m).

In some of the studies where chloracne developed, signs of liver injury were not found [186,194,195], but in the majority of studies where

chloracne was found, there were also indications of liver injury [190-193,196]. Evidence of impaired liver function was found by other investigators [197] in a study where workers had not developed chloracne. Meigs et al [190] found evidence of slight liver injury in workers exposed to PCBs at 0.1 mg/cu m, and Levy et al [197] found historical evidence of liver injury in the medical records of workers in the plant where they found exposures were <0.25 mg/cu m. Among the findings in these medical records were elevated serum triglycerides [197]. Abnormal serum triglycerides have been found in exposed workers by others [191-193], and in the Japanese people who accidentally consumed PCBs [155,157,158,175,179-181]. The effect on serum triglycerides in workers was related to duration of exposure [193] and, in the workers and in the Yusho patients, to residual PCBs in the blood [175,180,193]. In the Japanese workers who were removed from exposure, the effect remained for at least 2 years [193].

Other indications of liver injury in exposed workers included occasional findings of elevated serum enzyme activities, and abnormalities in various other liver function tests [190,191,196,197]. A level of exposure at which liver injury will not occur is not indicated by the occupational exposure studies, since evidence of liver injury has been found in the occupational studies with the lowest PCB concentrations. It is not possible to determine whether liver injury occurred with exposures at the lower levels of all the occupational exposure ranges reported, but to protect workers from any liver injury it seems that exposures should be maintained below 0.01 mg/cu m (10 µg/cu m).

Animal experiments do not demonstrate a safe exposure level either. Although Treen et al [203] found no evidence of liver injury in

experimental animals (rabbits, guinea pigs, cats, rats, and mice) exposed to Aroclor 1242 at concentrations of 1.9-8.6 mg/cu m for up to 31 weeks, Ouw et al [196] found evidence of liver injury in workers exposed to Aroclor 1242 at 0.32-1.44 mg/cu m. In their experiments with Aroclor 1254, Treon et al [203] found microscopic evidence of liver injury in animals exposed at 1.5 mg/cu for 31 weeks. Linder et al [228] found increased liver weights in rats fed Aroclor 1254 at 1 ppm for two generations. The intake of PCBs at this dietary level can be compared to the intake from inhalation exposure at about 0.1-0.2 mg/cu m; thus, the animal experiments appear to confirm indications of liver injury in workers exposed to PCBs in this range. The combined studies of Levy et al [197], Meigs et al [190], Hasegawa et al [191], and Ouw et al [196], and the animal studies [203,228], provide further support to the conclusion that PCB exposures must be maintained at lower levels to prevent liver injury than to prevent chloracne.

Since indications of liver injury can be found in reports of both occupational studies [190,191,196] and animal experiments [203,228] with the lowest PCB exposure, there is no proof of an exposure level that is adequately low to prevent liver injury.

The prevention of liver injury is of particular concern because there is substantial evidence that arene oxides are formed during the metabolism of PCBs by animals [51,68,69,74,75,81,115,116,118], and the data offer no reason to suspect that humans metabolize PCBs differently from animals. PCB metabolites have been demonstrated to bind to nuclear components of hepatic cells of rhesus monkeys [51] and rats [81] and this is sufficient evidence to arouse suspicions that PCBs could be potential carcinogens in

the workplace. Commercial PCB preparations that have been adequately tested in rats [219,242] (Federal Register 42:6532-55, February 2, 1977) and mice [221,240,241] have been demonstrated to cause liver tumors. No liver tumors were found in rats fed Aroclors 1242, 1254, and 1260 at 1 ppm in the diet, but each of these mixtures produced tumors at 10 ppm (Federal Register 42:6532-55, February 2, 1977). In this same experiment a high incidence of pituitary tumors was found in PCB-fed rats. In Yusho patients [160,161], and in American workers (written communications, HA Sinclair, June 1976; G Rousch, September 1976), preliminary studies only indicate that the occurrence of certain cancers may be excessive. However, the findings in rats and mice demonstrate reproducible production of liver tumors after ingestion of various PCB mixtures, and NIOSH concludes that PCBs in workplace air are potential carcinogens.

Additional concerns for the health of workers and their families are adverse reproductive effects [228,230,232,233], including terata in animals fed various PCBs (FL Earl et al, written communication, 1976), and adverse effects in human and animal infants nursed by PCB-exposed mothers [101,182,233]. PCBs resembling those in maternal blood both qualitatively and quantitatively have been found in human cord blood and in tissues of newborn humans and animals [101,138,139,168]. Fetal resorptions were common, and dose related incidences of terata were found in pups and piglets when bitches and sows were fed Aroclor 1254 at 1 mg/kg/day or more. Terata were not found in babies of Yusho patients (maximum consumption of PCBs of about 0.15 mg/kg/day); however, many undesirable effects including low birth weights and chloracne-like lesions at birth and after nursing were found [176,182,183].

Based on the findings of adverse reproductive effects, on its conclusion that PCBs are potential carcinogens in humans and on its conclusion that occupational and animal studies have not demonstrated a level of exposure that will not subject the worker to possible liver injury, NIOSH recommends that the TWA concentrations of PCBs in the breathing zone of workers be maintained at or below the minimally detectable TWA concentration for up to a 10-hour workday, 40-hour workweek. NIOSH considers the minimally detectable concentration of PCBs for the monitoring of occupational exposures to be 1 $\mu\text{g}/\text{cu m}$, based on its review of the literature and the methodology presented in Appendices I and II.

Maintenance of exposures to PCBs at or below this concentration should reduce risks of reproductive and carcinogenic effects, and protect the employees from metabolic dysfunction, hepatic injury, and dermal effects due to PCB exposures during their working lifetimes.

It is recognized that employees handling PCBs may have skin contact with these substances, potentially resulting in dermatologic and systemic effects. Consequently, appropriate work practices, training programs, and other measures should be required, regardless of the concentrations of airborne PCBs. Therefore, occupational exposure to PCBs has been defined as working with PCBs or with equipment containing PCBs that can become airborne or that can spill or splash on the skin or into the eyes, or the handling of any solid products that may result in exposure to PCBs by skin contact or by inhalation.

(b) Sampling and Analysis

Based on an evaluation of the literature and on its own studies, NIOSH recommends sampling and analysis for PCBs as detailed in Appendix I

and II. Florisil has been selected as the solid sorbent for PCBs because it will collect vapors as well as particulates and PCBs can be quantitatively recovered from it. The recommended Florisil sampling tubes have been shown to have an adequate sorption capacity (at least 100 μg) for monitoring occupational exposures at the recommended limit for up to a 10-hour workday. NIOSH has used the sampling method for monitoring TWA occupational exposures at 10-250 $\mu\text{g}/\text{cu m}$ [197,244] by sampling at about 200 ml/minute for the entire workday. Total sample volumes of up to 100 liters were collected. At 1 $\mu\text{g}/\text{cu m}$, 100 liters of air would contain 100 ng of PCBs. The lower limit of PCB detection by GLC with EC detection was found to be 32 pg/4- μl injection. Since the contents of the Florisil tubes are dissolved in 5 ml of solvent, this represents a total of 40 ng of adsorbed PCBs. Although NIOSH recommends sampling at 200 ml/minute, it may be feasible to use pumps that sample at faster rates if there are analytical difficulties with samples of about 100 liters due to low concentrations of PCBs.

(c) Medical Surveillance

Occupational exposure to PCBs has been shown to cause signs of liver injury and impaired liver function. Ouw et al [196], Hasegawa et al [191], and Levy et al [197] all found occasional incidents of elevated serum enzymes; exposure conditions under which these will not occur are not known. Therefore, NIOSH recommends determination of SGOT and SGPT initially and at annual intervals. The responsible physician may also wish to determine serum triglyceride concentrations since these have been found to be abnormal in some workers chronically exposed to PCBs [191-193,197]. Especially, elevated serum triglyceride concentrations have been found to

be related to duration of exposure and to the concentration of residual PCBs in the blood [193].

Although the data indicate that the recommended standard will prevent chloracne, it is not known that it will prevent other skin ailments. NIOSH recommends that in comprehensive physical examinations, special emphasis be given to the condition of the skin.

PCBs fed to bitches and sows have been found to be teratogenic (FL Earl et al, written communication, 1976). Although terata have not been observed in human babies whose mothers had been exposed to PCBs [176,182,183], PCBs have been found in human embryos and fetuses [138,139,168], and undesirable effects (abnormal skin color and low birth weights) have been observed in neonates [176,182,183] born after their mothers had ingested PCBs. A woman who was occupationally exposed to PCBs had a blood PCB concentration of 25 ppb when her normal baby was born [195]. NIOSH considers that its recommended standard will protect unborn babies but recommends that women exposed to PCBs at work be advised of the potential hazards of PCB exposure to unborn children.

PCBs have been found in milk of women who have been exposed to PCBs [168,195] and babies have been adversely affected after being nursed by PCB-exposed mothers [182]. A safe level of PCBs in the milk of mothers occupationally exposed to PCBs is not known. Human milk samples in the general US population usually contain detectable amounts of PCBs, and about one-third of the whole milk samples have been found to contain >50 ppb and up to about 350 ppb (EP Savage, written communication, February 1977). It is not known if all the mothers from whom these samples were taken nursed their babies without effect. Infant monkeys who were nursed by mothers

in their milk at 150-350 ppb became sick and developed chloracne [234]. After consultation, the woman who was occupationally exposed to PCBs and who had PCBs in her milk at about 250 ppb, stopped nursing her baby out of concern for its health [195]. Based on these considerations, NIOSH recommends that women working with PCBs be counseled concerning the advisability of nursing their babies.

(d) Personal Protective Equipment and Clothing

PCBs applied to the skin or cornea of experimental animals have been shown to cause local lesions and liver and kidney injuries [205-208,225]. One worker who developed chloracne after 3 months of exposure to PCBs was described as having frequently immersed his hands in the PCB mixture and his clothes were described as often being impregnated with PCBs [189]. Employees working with an askarel containing 60% Aroclor 1254 frequently developed skin rashes which were considered by the company physician to be allergic or contact dermatitis from the askarel (In the Matter of General Electric Company, File No. 2833, New York State Department of Environmental Conservation, 1975). Other complaints of these workers that were ascribed to the askarel included irritation of the eyes, nose and throat. Levy et al [197] and Ouw et al [196] found that employees exposed to PCBs at 0.013-0.264 mg/cu m and 0.32-1.44 mg/cu m, respectively, complained of similar irritations and, on examination, there were findings of skin rashes and nasal irritation. Ouw et al [196] considered that one reason the blood PCB concentrations in workers they studied did not decline (after improvements in the ventilation system had reduced the environmental concentrations of PCBs) was because the workers did not comply with the recommendations for protecting their skin from PCB contact.

Based on these reports [189,196,197,205-208,225], NIOSH recommends that employees working in situations where skin contact may occur be provided with clothing that is impervious to PCBs and that will cover all body surfaces where contact may occur. To prevent splashing PCBs into the eyes, NIOSH recommends that employees wear appropriate goggles or safety glasses in accordance with 29 CFR 1910.133 and ANSI Z87.1-1968. Since NIOSH has found PCBs to be potential carcinogens and recommends that exposures be maintained at or below 1 $\mu\text{g}/\text{cu m}$, it considers that only a self-contained breathing apparatus with a full facepiece operated in the positive-pressure mode will provide adequate protection when workers are in areas where higher concentrations exist. Based on NIOSH studies [287-289], other respiratory protective devices are not considered adequate to provide the needed protection.

(a) Other Considerations

Engineering controls are recommended to maintain PCBs in closed systems to reduce exposures to the extent feasible. Such a recommendation is consistent with the Toxic Substances Control Act (Public Law 94-469) and with the need to protect employees from exposure to PCBs. However, there are situations, such as in accidental leakage from closed systems and in repair of equipment, when PCBs may not be confined. The recommended standard prescribes general work practices for PCBs as well as emergency work practices. Employees should be informed of the hazards of working with PCBs, and trained in the recommended general work practices and the procedures to follow in emergencies. The advantages to their health of complying with the work practices and medical monitoring requirements of the recommended standard should be explained to the employees. As Ouw at

al [196] pointed out, improving air quality does not go far in alleviating the workers' body burdens of PCBs without their cooperation in implementing the recommendations for protecting their skin from PCB contact.

NIOSH also recommends certain sanitation practices to minimize intake of PCBs by employees. Among these practices is the requirement that employees be provided with clean work clothing daily and that they change clothing before leaving work. The importance of this measure to the employee and the employee's family is exemplified in finding up to 180 ppm of PCBs in the dust of PCB-workers' homes [36]. PCBs may remain in contaminated premises for years [33]. Partly for the same reason, and because PCBs in contact with the skin can be irritating [196,197] and also because they have caused systemic effects in experimental animals [205-208,225], NIOSH recommends that workers shower before leaving work.

Toxic effects from ingestion of PCBs have been well documented in humans [145-185] and experimental animals [101,209-224,226-237,240-248]. Workers may have an intake of PCBs from their normal diet of 10-20 $\mu\text{g}/\text{day}$ [46], and the maximum additional intake expected from NIOSH's recommended allowable work exposures might be of the order of 10 μg . NIOSH recommends that workers wash their hands before eating and that food, drinks, and smoking materials not be permitted in PCB work areas. The importance of this recommendation may be evaluated by considering that one drop of PCBs spilled on food, in drinks, or otherwise conveyed into the mouth may contain about 50 μg of PCBs, compared to a total intake of 20-30 μg from other sources, including allowable occupational exposures.

Because the consequences of working with PCBs may be substantial, NIOSH recommends that entry into PCB work areas be restricted to authorized

employees whose entry is logged daily, and whose exposures are monitored at least annually to ensure that airborne exposures are at or below the recommended TWA limit.

VII. RESEARCH NEEDS

There is a clear need for information in the following areas:

(a) The effects of chronic exposure of animals and humans to PCBs at low concentrations require investigation. Epidemiologic studies of occupational groups and information on concentrations of PCBs in workroom air and any related clinical findings would be useful.

(b) Chronic exposures of animals to PCBs at concentrations in the range of the recommended environmental limit.

(c) Studies of the reproductive histories of women who have been exposed to PCBs in their occupational environments, including studies of status and development of infants born to these women.

(d) The absorption efficiencies of various PCB mixtures by the dermal and respiratory routes.

(e) The method of transport of PCBs in the blood and the partition between blood on the one hand, and fat stores and milk on the other.

(f) A problem that confounds our understanding of the toxicity of PCBs is that of the toxic activity of contaminants associated with PCBs. The contaminants found in commercially important PCB products should be identified, prepared in pure form and studied toxicologically both as individual substances and as mixtures with other, related compounds.

(g) Studies regarding methods of removing PCBs from the skin (cleansing).

(h) Studies on the use of various barrier creams as a means of minimizing dermal exposure to PCBs.

(1) There is uncertainty regarding baseline values for PCBs in the blood of humans; research should be conducted to determine baseline values for the general population and for non-exposed industrial populations.

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IX. APPENDIX I
SAMPLING PROCEDURE FOR
COLLECTION OF POLYCHLORINATED BIPHENYLS

General Requirements

(a) Air samples representative of the breathing zones of workers must be collected to determine the exposure from each job or from the specific operation in each work area.

(b) Suggested records:

- (1) Date and time of sample collection;
- (2) Pump model and serial number;
- (3) Sample tube type and number;
- (4) Sampling duration;
- (5) Total sample volume;
- (6) Location of sampling;
- (7) Temperature, pressure, and relative humidity at time of sampling;
- (8) Other pertinent information.

Calibration

Since the accuracy of environmental sampling can be no greater than the accuracy of the air volume measurement, the accurate calibration of the sampling pump is essential to the correct estimation of the volume of the sample that is collected. The required frequency of calibration is dependent on the use, care, and handling to which the pump is subjected. Pumps should be calibrated initially and recalibrated if misused or

repaired. If pumps receive hard usage, more frequent calibration may be necessary. Regardless of use, maintenance and calibration should be performed on a regular schedule and records of these should be kept.

The accuracy of calibration depends on the type of instrument used as a reference. The choice of calibration instrument will depend largely upon where the calibration is to be performed. Ordinarily, pumps should be calibrated in the laboratory. For laboratory testing, primary standards, such as a spirometer or a soapbubble meter, are recommended, although other standard calibration instruments, such as a wet-test meter or dry gas meter, can be used. The calibration setups will be similar for all instruments.

Instructions for calibration with the soapbubble meter follow. If another calibration device is selected, equivalent procedures should be used. Since the flowrate of a pump depends on the pressure drop across the sampling device, in this case a "Florisil" tube, the pump must be calibrated while operating with a representative tube in line. The calibration system should be assembled in series following this order: soapbubble meter, water manometer, Florisil tube, and pump.

(a) Check the voltage of the pump battery with a voltmeter to ensure adequate voltage for calibration, and change or charge the battery if necessary.

(b) Turn on the pump and moisten the inside of the soapbubble meter by immersing the buret in the soap solution and drawing bubbles up the inside until they travel the entire buret length without bursting.

(c) Adjust the pump rotameter to provide the desired flowrate.

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(d) Check the water manometer to ensure that the pressure drop across the sampling train does not exceed 2.5 inches of water at 0.2 liter/minute.

(e) Start a soapbubble up the buret and measure with a stopwatch the time required for it to move between calibration marks.

(f) Repeat procedure (e) at least twice, average the results, and calculate the flowrate from the volume between the preselected marks divided by the time required for the soapbubble to traverse the distance.

(g) Record the volume measured, elapsed time, pressure drop, air temperature, atmospheric pressure, serial number of pump, date, time, and name of person performing the calibration.

(h) The rotameter reading should be corrected for temperature and pressure, if necessary.

Sampling

(a) Samples should be collected as near as practicable to the faces of workers without interfering with freedom of movement.

(b) Samples should be collected to permit determination of TWA exposures for every job involving exposure to PCBs and in sufficient numbers to express the variability of the exposures in the work situation.

(c) Apparatus for Breathing Zone Sampling

(1) Pump, battery-operated, with clip for attachment to the worker's clothing. Airflow through the pump should be controlled within 5% of the desired rate during the entire sampling period.

(2) Sorbent Tubes

Glass tubes at least 7 cm long with 4 mm I.D. and containing

two sections of 30/48 mesh deactivated Florisil. (Florisil, 30/60 mesh, is sieved to the proper mesh size.) The front section, preceded by a glass wool plug, contains 100 mg adsorbent, and the backup section contains 50 mg. A urethane foam plug is placed between these sections and also behind the backup section. The ends of the tube are flame-sealed to prevent contamination before use.

Deactivate the Florisil before packing the tubes by drying a weighed amount at 105 C for 45 minutes. After cooling to room temperature, add the Florisil to a round bottom flask which can be attached to a rotary evaporator. Add water at 3 ml/100 g of Florisil (ie, 3% W/W water) and turn the mixture in the rotary evaporator for 1 hour or until it is uniformly mixed (free-flowing).

(d) Collection and Shipping of Samples

(1) Immediately before sampling, break each end of the sorbent tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

(2) The smaller, or backup, section of Florisil should be positioned nearest the sampling pump.

(3) The sorbent tube must be vertical during sampling. Tubes should not be placed in a horizontal position since this may lead to "channeling" of the sorbent bed.

(4) Do not pass air being sampled through any hose or tubing before it enters the tube.

(5) Collect the air sample at a flow rate of 200 cc/minute or less to obtain the total sample volume required. The recommended maximum sampling volume for this method is 50 liters.

(6) Cap the sorbent tubes with inert plastic caps immediately after sampling. Under no circumstances are rubber caps to be used. Label tubes and note precise location assignments.

(7) Handle one additional tube in the same manner as the sample tubes except that no air is to be drawn through it. Label this tube as a blank.

(8) If the tubes are to be shipped, pack them tightly to minimize breakage in transit.

(9) Do not subject the tubes to extremes of temperatures or to low pressures.

(10) Provide bulk samples of the PCB preparation whose presence in the environment is suspected to the analytical laboratory. Do not transport these bulk materials in the same container as the samples or blank tubes. If possible, also provide a bulk air sample to use for qualitative identification.

X. APPENDIX II

ANALYTICAL METHOD FOR POLYCHLORINATED BIPHENYLS

Principle of the Method

A known volume of air is drawn through a tube containing Florisil to adsorb the PCBs present in the air sample. The collected PCBs are desorbed with hexane, and the resulting solutions are analyzed using gas-liquid chromatography with electron capture detection. The concentration of PCBs relative to a standard PCB preparation is read from a standard curve. If the air sample is found to differ significantly in composition from available PCB standards, then use the alternate procedure of perchlorination described in paragraph (b)7 of Procedure.

Range and Sensitivity of the Standard Analysis

NIOSH has found with Aroclor 1016, that the minimum detectable amount of PCB is 32 pg/4 μ l. With a total desorption volume were 5 ml, this would represent a total sample of 40 ng of Aroclor 1016. Thus the method is capable of detecting a concentration of 40 ng in a 1 cu m air sample, or a concentration of about 1 μ g/cu m in an air sample of 50 liters. The upper range of the analytical method is apparently limitless depending only upon the degree of dilution needed to maintain the concentration of the sample within the linear range of the electron capture detector (32 pg to 3 ng/injection). In practice, concentrations in workplace air have been found to be as high as 1.5 mg/cu m.

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Interferences

(a) Strict measures to avoid contamination are required when using the electron capture detector. Foremost, the syringe must be thoroughly cleaned after each injection. Hexane to be used in the analytical procedure should be periodically analyzed by GLC for purity. It should show no chromatographic peaks later than 45 seconds, if less than 5 μ l have been injected.

(b) Any compound which has nearly the same retention time on the GLC column as one of the PCBs is an interferent. This type of interference can often be overcome by changing the GLC operating conditions or by selecting another column. Retention time data on a single column, or even on a number of columns, cannot be considered as proof of chemical identity. It is important, therefore, that a sample of the bulk mixture of PCBs be analyzed at the same time as the contents of the sample tubes so that chemical identification of possible interferences can be made.

(c) The interferences which have been reported in the literature in the GLC analysis of PCBs are not expected to be important for this method. Chlorinated pesticides, such as DDT, DDE, etc, have been reported as interferences due to coextraction with PCBs during workup of samples such as water, tissue, soil, or biologic fluids. In the case of personal air sampling in an industrial environment, these interferences would not be present in amounts that would significantly interfere unless they were manufactured in the same area. Thus, unless these chlorinated pesticides are specifically known as potential interferents, extra cleanup or separation steps for these materials are not necessary.

(d) Sulfur-containing compounds in petroleum products have been reported as interferences.

(e) If present in the PCB mixture, biphenyl will be an interference when samples are analyzed by perchlorination; however, PCBs for the purpose of this recommended standard include biphenyl.

(f) Brominated impurities in antimony pentachloride have also been found to lead to interferences in perchlorination procedures. Results from NIOSH laboratories indicate, however, that these brominated impurities may be removed by vacuum distillation of the antimony pentachloride.

Precision and Accuracy

The performance characteristics of the method as found by NIOSH are presented below.

(a) The volume of air sampled can be measured to $\pm 1\%$ if a pump with a calibrated volume indicator is used. Volumes calculated from initial flow rate settings may be less accurate ($\pm 5\%$) because of changes in flow rate during sampling.

(b) At airborne PCB concentrations of up to 10 mg/cu m, the front section of the Florisil tube has a 100% collection efficiency for 50-liter air samples.

(c) Recovery of known amounts of PCBs adsorbed on Florisil is quantitative (100%).

(d) Sealed tubes or desorbed sample solutions can be stored for 2 months without PCB loss.

(e) The precision of the analysis is dependant upon the precision and sensitivity of the technique used to quantitate the GLC peaks of the

samples and standards. The precision of the standard analytical procedure has a relative standard deviation of 4.4%.

(f) The average conversion of PCBs to decachlorobiphenyl is about 100% with a relative standard deviation of about 2%.

(g) Recovery of decachlorobiphenyl subjected to the decachlorination procedure is >99% with a relative standard deviation of 1.8%.

(h) The accuracy of these procedures is not known; accuracy depends on the ability to separate and identify each compound in the PCB mixture and to compare each with a known standard. Many of the isomers in commercial PCB mixtures have not been separated or identified, and standards for many of the isomers are not available.

Advantages of the Sampling and Analytical Methods

(a) The sampling device is small, portable, and involves no liquids.

(b) The capacity of the solid sorbent sampling device for PCBs is large and recovery of PCBs from the sorbent is quantitative.

(c) The contents of the sample collection tubes are analyzed by means of a rapid instrumental method.

(d) Interferences are minimal, and most of those which do occur can be eliminated by altering chromatographic conditions.

(e) The perchlorination procedure provides qualitative confirmation and quantitative measure of PCBs, since it is based on measurement of the single GLC-EC detection response of decachlorobiphenyl.

Disadvantages of the Sampling and Analytical Methods

(a) The precision of the sampling method is limited by the reproducibility of the pressure drop across the tubes. Pressure drop changes will result in variability in the flow rate and cause the sampling volume to be imprecisely known because the pump is usually calibrated for only one tube.

(b) A substantial difference between the composition of PCBs in the air sample and that of the commercial PCB mixture being used as a standard will result in a large error in accuracy when the standard analytical procedure is used, since estimation of the PCB content of the sample is based on comparison with such a PCB mixture.

Apparatus

(a) Gas liquid chromatograph equipped with an electron capture detector capable of maintaining a detector temperature of 350 C.

(b) Glass column (6 feet x 2 mm I.D.) packed with 1.5% OV-17/1.95% QF-1 on 80/100 mesh Supelcoport.

(c) Vials (20-ml), with aluminum-lined caps.

(d) Microliter syringe (10- μ l).

(e) Volumetric flasks (10-ml for standards) with glass stoppers.

(f) Method for determining peak areas.

(g) Culture tubes, 13 x 100 mm, with unlined screw top caps.

(h) Oven, capable of maintaining 160 C $\pm$ 5 C.

(i) Sand bath.

(j) Vortex mixer.

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Reagents

- (a) Hexane, pesticide-grade quality.
- (b) Nitrogen carrier gas, prepurified.
- (c) PCB mixture under study.
- (d) Antimony pentachloride, distilled under vacuum.
- (e) Decachlorobiphenyl.
- (f) Sodium sulfate, anhydrous.
- (g) Hydrochloric acid, 20% aqueous.

Calibration and Standards

(a) Standardization Procedure

Use the particular PCB mixture as the standard that was being used in the work area in which air samples were taken. Prepare standards in hexane at concentrations ranging from 8 to 500 ng/ml. Calibration curves should be established daily since the electron capture detector response may vary from day to day. Plot the standard curve in terms of concentration (ng/ml) versus area. Since the injection volumes of the standard and the sample are identical, the concentration of the sample can be read directly from the standard curve.

(b) Alternate Standardization Procedure (Perchlorination)

The product of the perchlorination of the PCB mixture with antimony pentachloride is decachlorobiphenyl. Standards of decachlorobiphenyl are prepared in hexane at concentrations ranging from 70 to 440 ng/ μ l. Calibration curves are established daily since the electron capture detector response may vary from day to day. The standard curve is plotted in terms of concentration (ng/ml) versus peak area. Since the injection

volume of the standard and the sample are identical, the concentration of the sample can be read directly from this curve.

Procedure

(a) Cleaning of Equipment

All glassware used for the laboratory analysis should be washed with a detergent, thoroughly rinsed with tap water, distilled water, pesticide-grade acetone, and finally pesticide-grade hexane and then dried.

(b) Analysis of Samples

(1) Preparation of Samples

Score each tube with a file and place the glass wool and front section in a clean, dry vial. Place the separating urethane foam plug, the back section of the sorbent, and the retaining urethane foam plug in a second clean, dry vial. The front and back sections are analyzed separately.

(2) Desorption of Samples

Prior to analysis, pipet 5.0 ml of hexane into each vial. Florisil particles should not be allowed to cling to the glass above the solvent. A minimum desorption time of 10 minutes is required before analysis.

(3) Gas-liquid chromatographic conditions for PCB determination by this procedure are:

- (A) Nitrogen carrier gas flow rate, 60 ml/minute.
- (B) Injector temperature, 300 C.
- (C) Interface and detector temperatures, both 325 C.
- (D) Column temperature, 180 C.

(4) Sample Injection

The solvent-flush technique is recommended for injection of materials into the GLC apparatus. With this method, the following procedure would be used to inject 4 μ l of sample. Three microliters of hexane would be drawn into the syringe, followed by 1 μ l of air, followed by 4 μ l of sample solution. After the needle is removed from the sample solution, 1 additional μ l of air is drawn into the syringe to minimize evaporation at the tip of the needle. The plunger now rests at the 9- μ l mark. Inject at least 7 μ l of the syringe contents into the gas chromatogram. Not less than 1 μ l of flush-solvent should be used. Larger volumes of flush may give a solvent peak which interferes with sample component peaks. The syringe must be cleaned with hexane after each injection.

(5) Preliminary Analysis

Using the solvent-flush method of subsection b(4), inject 1 μ l of sample and 1 μ l of flush-solvent at the conditions specified under subsection b(3). If the sample is too concentrated, further dilutions will be necessary to bring the concentration of the sample solution into the linear range of the electron capture detector. Once the concentration of the sample is appropriately adjusted, its chromatogram should be compared to that of a standard to determine if the air sample is qualitatively different in composition from the standard. If there is little difference between the two chromatograms, then proceed with the standard analysis using the PCB mixture for standardization, subsection b(6). On the other hand, should there be a significant difference between the two chromatograms (such that comparison with the PCB mixture could result in

gross error), then use the alternate procedure for standardization, subsection b(7).

(6) Standard Analysis

Select at least five prominent peaks in the sample chromatogram and compare their heights or areas with those of the standard. Calculate the concentration of PCBs by comparing the heights or areas of the selected peaks in the sample chromatogram of those in the standard chromatograms of known amounts of material.

(7) Alternate Standardization Procedure

A 200- μ l aliquot of the sample is placed in a 13-mm x 100-mm culture tube and the hexane is slowly evaporated with dry nitrogen until 10 μ l or less remain. Do not allow hexane to climb the tube during evaporation and do not allow the sample to evaporate to dryness. Immediately add 0.2-0.5 ml of distilled antimony pentachloride with a disposable pipet as rapidly as possible (antimony pentachloride decomposes rapidly in air) and cap the tube. The sample should remain light yellow after this addition, but if the sample turns dark brown or black, it must be discarded and another aliquot of that sample must be used. All samples are placed together in a sand bath. There should be no liner in the cap of the tube, since most liners are attacked by antimony pentachloride. A sample of decachlorobiphenyl is treated in a manner similar to the samples. The sand bath containing all of the treated samples is placed in a preheated oven at 160 C for at least 3 hours. Samples may also be treated overnight. After perchlorination, the sand bath is removed from the oven and the samples are removed from the sand and allowed to cool to room temperature. To each sample is added dropwise 0.5 ml of 20% hydrochloric acid. This mixture is

then extracted four times with 1-2 ml of hexane each time. Each extract is passed through a funnel containing approximately 0.5 g of anhydrous sodium sulfate (retained by a glass wool plug) into a 10-ml volumetric flask. The volume of the sample is brought to 10 ml by rinsing the pipet, sodium sulfate, and funnel tip with hexane. The funnel should not rest on the lip of the flask during filtration. The glass wool plug and sodium sulfate in the funnel are replaced after each sample. An aliquot of the sample solution is injected under the GLC conditions described above. The solvent flush technique is recommended using 2 μ l of solvent back flush and 6 μ l of standard or sample solution. The syringe must be cleaned with hexane after each injection. The height or area of the decachlorobiphenyl peak is compared to that of the decachlorobiphenyl standard and the weight of decachlorobiphenyl present is calculated.

(8) Gas-liquid chromatographic conditions for decachlorobiphenyl determination:

- (A) Nitrogen carrier gas flow rate, 90 ml/minute.
- (B) Injector temperature, 300 C.
- (C) Interface and detector temperature, 325 C.
- (D) Column temperature, 220 C.

(c) Determination of Desorption Efficiency

NIOSH has found average desorption efficiency is >99.3%, thus, results of sample analyses need not be corrected for desorption efficiency.

Calculations

(a) Standard Analytical Procedure

The following are the steps in the calculation of concentrations of

PCBs in air when determined with a PCB mixture as the standard.

(1) Add the heights or areas of several selected prominent peaks (at least five) in the chromatogram, compare with the total heights or areas of those same peaks in the standard, and read the concentration of the sample solution (ng/ml) from the standard curve.

(2) Multiply the concentration, in ng/ml, of the sample solution by the total volume, in ml, of the sample solution and calculate the weight of PCBs in the sample. Make corrections for the blanks if necessary.

(3) Add the weights found on the front and the back sections of the tube to find the total weight of PCBs in the air sample.

(4) Divide the total weight of the PCBs in the air sample by the volume, in liters, of air sampled and report the PCB concentration in ng/liter or its equivalent in $\mu\text{g}/\text{cu m}$.

(b) Alternate Standardization Procedure

The following are the steps in the calculation of concentrations of PCBs in air using the perchlorination method.

(1) The height or area of the decachlorobiphenyl peak in the chromatogram of the sample aliquot is compared to the height or area of the decachlorobiphenyl peak in the chromatograms of the standard. The concentration of decachlorobiphenyl in the sample aliquot is read from the standard curve.

(2) The concentration of decachlorobiphenyl in this aliquot (ng/ml) is multiplied by the total volume (ml) of the sample solution to give the total weight of PCBs in the sample as decachlorobiphenyl.

(3) The weights of PCBs, as decachlorobiphenyl, found on the front and back sections of the tube are summed, corrections for blanks are made, and the total weight of PCB, as decachlorobiphenyl, in the air sample is calculated.

(4) The total weight of PCB is divided by the volume of air sampled and the air concentration is reported in ng/liter or its equivalent in $\mu\text{g}/\text{cu m}$.

XI. APPENDIX III
MATERIAL SAFETY DATA SHEET

General instructions for preparing a Material Safety Data Sheet (MSDS) are presented in this chapter. The examples used in the text are for illustrative purposes and are not intended to apply to any specific compound or product. Applicable information about a specific product or material shall be supplied in the appropriate block of the MSDS.

The product designation is inserted in the block in the upper left corner of the first page to facilitate filing and retrieval. Print in upper case letters as large as possible. It should be printed to read upright with the sheet turned sideways. The product designation is that name or code designation which appears on the label, or by which the product is sold or known by employees. The relative numerical hazard ratings and key statements are those determined by the guidelines in Chapter V, Part B, of the NIOSH publication, An Identification System for Occupationally Hazardous Materials. The company identification may be printed in the upper right corner if desired.

(a) Section I. Product Identification

The manufacturer's name, address, and regular and emergency telephone numbers (including area code) are inserted in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially

formal chemical nomenclature. Every known chemical designation or competitor's trade name need not be listed.

(b) Section II. Hazardous Ingredients

The "materials" listed in Section II shall be those substances which are part of the hazardous product covered by the MSDS and individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, while a third component could be included both for its toxicity and its reactivity. Note that a MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

Chemical substances should be listed according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such as "aromatic amine," "safety solvent," or "aliphatic hydrocarbon" when the specific name is known.

The "%" may be the approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount, ie, "10-40% vol" or "10% max wt" to avoid disclosure of trade secrets.

Toxic hazard data shall be stated in terms of concentration, mode of exposure or test, and animal used, eg, "100 ppm LC50-rat," "25 mg/kg LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.1000," or, if not available, from other sources of publications such as the American Conference of Governmental Industrial Hygienists or the

American National Standards Institute Inc. Flashpoint, shock sensitivity or similar descriptive data may be used to indicate flammability, reactivity, or similar hazardous properties of the material.

(c) Section III. Physical Data

The data in Section III should be for the total mixture and should include the boiling point and melting point in degrees Fahrenheit (Celsius in parentheses); vapor pressure, in conventional millimeters of mercury (mm Hg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicate if by weight or volume) at 70 degrees Fahrenheit (21.1 degrees Celsius); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for design and deployment of adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers, or when spilled.

(d) Section IV. Fire and Explosion Data

Section IV should contain complete fire and explosion data for the product, including flashpoint and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special firefighting procedures; and unusual fire and explosion hazard information. If the product presents no fire hazard, insert "NO FIRE HAZARD" on the line

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labeled "Extinguishing Media."

(e) Section V. Health Hazard Information

The "Health Hazard Data" should be a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable limit. Other data are acceptable, such as lowest LD50, if multiple components are involved.

Under "Routes of Exposure," comments in each category should reflect the potential hazard from absorption by the route in question. Comments should indicate the severity of the effect and the basis for the statement, if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as "yes" or "possible" are not helpful. Typical comments might be:

Skin Contact--single short contact, no adverse effects likely; prolonged or repeated contact, irritation, and cracking. Readily absorbed through the skin with severe systemic effects.

Eye Contact--some pain and mild transient irritation; no corneal scarring.

"Emergency and First Aid Procedures" should be written in lay language and should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Information in the "Notes to Physician" section should include any special medical information which would be of assistance to an attending physician including required or recommended preplacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed workers.

(f) Section VI. Reactivity Data

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. It is particularly important to highlight instability or incompatibility to common substances or circumstances such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. "Hazardous Decomposition Products" shall include those products released under fire conditions. It must also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, shelf life should also be indicated.

(g) Section VII. Spill or Leak Procedures

Detailed procedures for cleanup and disposal should be listed with emphasis on precautions to be taken to protect workers assigned to cleanup detail. Specific neutralizing chemicals or procedures should be described in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as "sanitary landfill," or "incineration." Warnings such as "comply with local, state, and federal antipollution ordinances" are proper but not sufficient. Specific procedures should be identified.

(h) Section VIII. Special Protection Information

Section VIII requires specific information. Statements such as "Yes," "No," or "If Necessary" are not informative. Ventilation requirements should be specific as to type and preferred methods. Specify respirators as to type and NIOSH or US Bureau of Mines approval class, ie, "Supplied air," "Organic vapor canister," "Suitable for dusts not more toxic than lead," etc. Protective equipment must be specified as to type and materials of construction.

(1) Section IX. Special Precautions

"Precautionary Statements" shall consist of the label statements selected for use on the container or placard. Additional information on any aspect of safety or health not covered in other sections should be inserted in Section IX. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

(j) Signature and Filing

Finally, the name and address of the responsible person who completed the MSDS and the date of completion are entered. This will facilitate correction of errors and identify a source of additional information.

The MSDS shall be filed in a location readily accessible to workers potentially exposed to the hazardous material. The MSDS can be used as a training aid and basis for discussion during safety meetings and training of new employees. It should assist management by directing attention to the need for specific control engineering, work practices, and protective measures to ensure safe handling and use of the material. It will aid the safety and health staff in planning a safe and healthful work environment and in suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of employees.

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION		
MANUFACTURER'S NAME		REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.
ADDRESS		
TRADE NAME		
SYNONYMS		
II HAZARDOUS INGREDIENTS		
MATERIAL OR COMPONENT	%	HAZARD DATA
III PHYSICAL DATA		
BOILING POINT, 760 MM HG		MELTING POINT
SPECIFIC GRAVITY (H ₂ O=1)		VAPOR PRESSURE
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H ₂ O, % BY WT
% VOLATILES BY VOL.		EVAPORATION RATE (BUTYL ACETATE=1)
APPEARANCE AND ODOR		

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IV FIRE AND EXPLOSION DATA				
FLASH POINT (TEST METHOD)			AUTOIGNITION TEMPERATURE	
FLAMMABLE LIMITS IN AIR, % BY VOL.		LOWER	UPPER	
EXTINGUISHING MEDIA				
SPECIAL FIRE FIGHTING PROCEDURES				
UNUSUAL FIRE AND EXPLOSION HAZARD				
V HEALTH HAZARD INFORMATION				
HEALTH HAZARD DATA				
ROUTES OF EXPOSURE				
INHALATION				
SKIN CONTACT				
SKIN ABSORPTION				
EYE CONTACT				
INGESTION				
EFFECTS OF OVEREXPOSURE				
ACUTE OVEREXPOSURE				
CHRONIC OVEREXPOSURE				
EMERGENCY AND FIRST AID PROCEDURES				
EYES				
SKIN:				
INHALATION:				
INGESTION:				
NOTES TO PHYSICIAN				

VI REACTIVITY DATA	
CONDITIONS CONTRIBUTING TO INSTABILITY	
INCOMPATIBILITY	
HAZARDOUS DECOMPOSITION PRODUCTS	
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION	
VII SPILL OR LEAK PROCEDURES	
STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED	
NEUTRALIZING CHEMICALS	
WASTE DISPOSAL METHOD	
VIII SPECIAL PROTECTION INFORMATION	
VENTILATION REQUIREMENTS	
SPECIFIC PERSONAL PROTECTIVE EQUIPMENT	
RESPIRATORY (SPECIFY IN DETAIL)	
EYES	
GLOVES	
OTHER CLOTHING AND EQUIPMENT	

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IX SPECIAL PRECAUTIONS

PRECAUTIONARY
STATEMENTS

OTHER HANDLING AND
STORAGE REQUIREMENTS

PREPARED BY _____

ADDRESS _____

DATE _____

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TABLE XII-1

CHEMICAL AND PHYSICAL PROPERTIES OF SOME AROCLORS

Aroclor	Chlorine, % w/w	Distillation Range, C (corrected)	Density g/ml 25 C	Flash- point* F	Fire- Point* F	Appearance
1221	20.5-21.5	275-320	1.18	286-302	349	Clear, mobile oil
1232	31.4-32.5	290-325	1.26	305-310	460	"
1242	42	325-366	1.38	384-356	none**	"
1248	48	340-375	1.44	379-384	"	"
1254	54	365-390	1.54	none**	"	Light-yellow viscous liquid
1260	60	385-420	1.62	"	"	Light-yellow soft, sticky resin
1262	62	390-425	1.64	"	"	Light sticky, viscous resin
1268	68	435-450	1.82	"	"	White to off-white powder

*Cleveland Open Cup

**None to boiling point

Adapted from reference 1

TABLE XII-2
QUALITATIVE AND PERCENT CHLOROBIPHENYL AND BIPHENYL COMPOSITIONS OF COMMERCIAL PCB PREPARATIONS
 (Qualitatively major peaks = M, minor peaks = m, ambiguous identities = ?; quantitatively, percentages rounded)

CL-Substituted Positions	Commercial Preparation Designations (trade names omitted)																				
	1221	1221	1221	1221	1232	1016	1242	1242	1242	1240	1240	1254	1254	1254	A50	1260	1260	1260	A60	A60	DP6
0	13	16	m	16	m	0.5	m	m	m					m							
2	28	32	m	35	m	1	m	0.8	m	m				m			m				
3	3	3	m	3																	
4	19	19	m	20	m	2								m			m				
2.3						0.4															
2.4	4	3		2		1		<0.7	m	<0.1				m			m				
2.5		0.2		tr				m	m												
2.6		0.3		0.4		tr		m													
2.7	9	5	m	5	m	7	m	<1.0	M	m				m			m				
2.3		3	m	2	m	1	m		M	m				m			m				
2.4	10	10	m	11	m	11	m	>5	M	m		0.5		m			m				
3.4		1		m				m													
3.5						tr															
3.3																					
3.4				1				m			>3										
4.4	6	4	m	4	m	2		1	M		>3			m			m				
2.3.4																					
2.3.5																					
2.3.6																					
2.2.3					m	5	m		M?	m											
2.3.3		0.1				tr			M?												
2.3.4						tr															
2.4.5																					
2.4.6																					
2.2.4		0.3	m	m	m	4	m	11	M	m	0			m			m				
2.3.4				m	m	4	m	>15	M	m	>13			m			m				
2.4.4		0.2		m	m	4	m	7	M?	m	3										
2.2.5		0.6		0.6	m	12	m	2	M	m	0.1			m							
2.3.5		0.2				9	m		M	m	>13										
2.4.5		0.2				10	m		m	m				m							
2.2.6						1	m		m	m				m							
2.3.6						0.3			M?												
2.4.6						2			M					m							
3.4.5																					
2.3.4		0.1				tr	m	16	M	m	21	0.3		m							
3.3.4									m												
3.4.4						2			M												

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TABLE XII-2 (Continued)

QUALITATIVE AND PERCENT CHLOROBIPHENYL AND BIPHENYL COMPOSITIONS OF COMMERCIAL PCB PREPARATIONS

(Qualitatively major peaks = M, minor peaks = m, ambiguous identities = ?; quantitatively, percentages rounded)

Cl-Substituted Positions	Commercial Preparation Designations (trade names omitted)																				
	1221	1221	1221	1221	1232	1016	1242	1242	1242	1248	1248	1254	1254	1254	A50	1260	1260	1260	A60	A60	DP6
7.15						u															
13.5						u															
16.5																					
23.45																					
23.45																					
23.45																					
27.10						3									1				0.7		
23.54						0.4		M		7		m									
23.45								m		m		m									
27.15								M?													
23.55																					
23.45						0.2															
27.16						<2															
23.56							6	M?		m											
23.45															2				1		
27.45						u		M?													
23.45																					
26.45																					
27.46														m			m				
23.46						<2		M?		m											
26.46						u															
7.345								M?													
13.45																					
16.45																					
27.35						1								m							
27.36						u															
27.35						1	m			m		m	4	M	2	<0.4			1		
27.36						1															
23.54								4	m												
23.55																					
27.46						1	m			m											
27.45						3	m	12	M?	m	16	m			1						
27.46						0.1															
23.46						tr	m	m		m											
23.45																					
23.55									M?												
27.55		0.14				2	m	tr	M?	m		m	8	M	5		m				

	1221	1221	1221	1221	1232	1016	1242	1242	1242	1248	1248	1254	1254	1254	A50	1260	1260	1260	A60	A60	DP6
27.56						2															
27.66						3															
33.44								1													
33.45																					
37.35																					
27.78																					
27.147						0.5	m	9	M	m	24			M	4	<0.4	m				
27.48														m							
23.458																					
27.343																					
23.343																					
23.445																					
27.346																					
23.346																					
23.446																					
27.356																					
23.356																					
23.458																					
27.334															1						
27.344																<16					
27.345									m		2		23.7	M	m	m	1				
27.346																					
23.344													m	M	4	<4					
23.345																					
27.333																					
27.343																5					
27.355														M	2		m			1	
27.356																					
23.343																					
23.355																					
27.336										m		m	m	M	3		0.3				
27.346												m	17								
27.356									M?			m	14	M	4	2	M			3	
27.366												m									
23.346														M	8		m			3	
23.356																					
27.343														M	1	m					
27.445									m		2	m		M	2					6	
27.455											1	m	m	M	7					6	
27.456																					
23.445											1	m	14	M	5	<16	m			2	
23.455																					
27.346																					
27.446									8	M?											

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Commercial Preparation Designations (trade names omitted)

08153

	1221	1221	1221	1221	1232	1016	1242	1242	1242	1248	1248	1254	1254	1254	A50	1260	1260	1260	A60	A60	DP6
27.33.55'																			3		
27.34.55'										<0.1					0.9	<16			2		
27.34.55'																					
27.33.56'															1				4		
27.34.56'																<15					
27.40.56'																					
27.40.56'												m	4	M	4	<4	M	m	13	m	m
27.40.56'												0.4	m	0.5					1		
27.40.56'																					
27.45.56'																					
27.44.56'																					
27.34.56'													m		0.5	4	M	m	1	m	m
27.33.56'														M	2		M	m	7	m	m
27.33.45.56																					
27.34.45.56																					
27.34.55.56																					
27.34.55.56																					
27.34.55.56																					
27.33.44.5														m	1	<4	M	m	4	m	m
27.33.45.5'															0.2	<9	m		0.9		
27.33.45.56'															0.3			m	4	m	m
27.34.45.5'															1	12	M	m	8	m	m
27.34.45.56'												2	m			<20	m				
27.34.45.56'															tr				tr		
27.33.44.56															0.1				0.4		
27.33.45.56'												m	m								
27.33.46.56'															0.1				0.4		
27.34.45.56															0.2	<20	M		2		
27.34.45.56'																					
27.34.45.56																					
27.33.45.56														m	0.3				2		
27.33.55.56															tr				0.5		
27.33.56.56'															1				1		
27.34.55.56															0.4				3		
27.34.55.56																					
27.33.44.56																					
27.34.45.56																					
27.33.45.56																					
27.33.45.56'																					
27.34.45.56'																					

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TABLE XII-2 (Continued)
 QUALITATIVE AND PERCENT CHLOROBIPHENYL AND BIPHENYL COMPOSITIONS OF COMMERCIAL PCB PREPARATIONS
 (Qualitatively major peaks = M, minor peaks = m, ambiguous identities = ?; quantitatively, percentages rounded)

CL-Substituted Positions	Commercial Preparation Designations (trade names omitted)																					
	1221	1221	1221	1221	1232	1016	1242	1242	1242	1248	1248	1254	1254	1254	A50	1260	1260	1260	A60	A60	DPS	
2,3,3',4,4',5,5',6																						
2,2',3,3',4,4',5,5'															0.4	2	m		0.7			
2,2',3,3',4,4',5,6		m															m					
2,2',3,3',4,5,5',6															0.1	5	m		0.7			
2,2',3,3',4,4',6,6'															tr	m						
2,2',3,3',4,5',6,6'															tr		m					
2,2',3,3',5,5',6,6'															tr		M					
2,2',3,3',4,4',5,6,6'																0.4	m		tr			
2,2',3,3',4,5,5',6,6'		m															m					
2,2',3,3',4,4',5,5',6																	m					
2,2',3,3',4,4',5,5',6,6'																		m				
Reference No:	17	*	16	*	16	*	16	*	14	16	*	16	*	14	7	*	14	8	7	16	8	

Reference No: 17 * 16 * 16 * 16 * 14 16 * 16 * 14 7 * 14 8 7 16 8

* PW Albro, written communication, November 1976

Company Adopts PCB Policy

The U. S. Environmental Protection Agency has notified the Electric Utility Industry that a group of chemicals known as polychlorinated biphenyls (PCB's) represents a potential hazard to the environment and to human health.

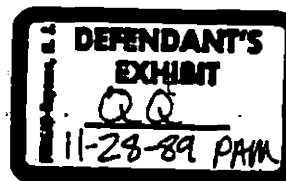
The Toxic Substance control act required the promulgation of rules prescribing marking and disposal requirements for PCB's.

The rules were promulgated with an effective date of April 18, 1973.

The intent of the regulations are to protect the environment from further contamination by PCB's resulting from improper handling and disposal.

Mr Ryan has stated that, "Nevada Power Company is committed to a balance of conservation and utilization of our natural resources and to ensure an adequate energy supply to the customers within our service area. Our environmental policies recognize that to achieve this goal our facilities and operations must be conducted and operated within environmental requirements".

PCB's are sometimes found as an additive in insulating fluids found in some capacitors and indoor transformers. During manufacture PCB's are intentionally added to transformers and capacitors because PCB's can reduce the likelihood of fire in electric equipment.



N. 06813

A000233

The regulations prescribe the approved methods of disposal when PCB's are taken from service and requirements for facilities used for the storage of PCB's prior to their disposal.

In addition to PCB-containing transformers and capacitors the law also applies to PCB articles, article containers, chemical substances, containers, equipment, and mixtures, all of which are defined in the regulation.

The regulation does not require that PCB's be removed from service earlier than would normally occur, but their eventual disposal must be in accordance with the requirements of the law. Currently, all company nonliquid waste is disposed of at a chemical landfill near Beatty, Nevada.

PCB's are among the most stable compounds known. Their chemical stability, low volatility, high dielectric constant, and compatibility with other hydrocarbons have contributed to their extensive use as dielectric and heat transfer fluids, as in capacitors and transformers.

The threat of PCB's to the environment was only recently acknowledged. the danger arises from their chronic toxicity, their pervasiveness and persistence in the environment, and their tendency to accumulate in food chains. PCB's have been found in significant concentrations in waterways and sediments throughout the world, and have recently been found in the milk of nursing mothers in many areas of the United States.

N. 06814

A000234

In view of the potential health effects of exposure to employees and the public, the Safety Department has been charged with the responsibility of developing, handling, and disposal procedures; also, employee and public education programs.

In addition to employee training programs for affected departments such as Lines, Substation, and Warehouse personnel, much interest has been shown by certain segments of the public and agencies. The Safety Department has developed a public presentation and information service for these groups. Special slide presentations have been made to the Public Service Commission and area fire departments. Within the company a Control and Handling Procedures manual has been prepared and distributed to all affected departments.

Because the PCB liquids are found in Line, Substation capacitors, and indoor transformers the Line and Substation Departments are the most affected.

A continuing education program has been implemented to ensure that all employees occupationally exposed to PCB's have current knowledge of job hazards, proper maintenance and cleanup methods, and proper use of protective clothing and equipment, including respirators.

MEMORANDUM

TO: Dave Barneby
Shelby Williams
Jack Crum
Bill James
Dave Odell
Charlie Stewart
Dan Crotta, Lines Dept.
CONFIDENTIAL SAFETY ENGINEER

DATE: May 29, 1978

FROM: Rickie Slate

SUBJECT: New PCB Disposal and
Marking Requirements

Attached is a letter from Clyde B. Eller, Director, Enforcement Division, EPA, Region IX, concerning new regulations concerning marking and disposal of transformers and related equipment containing PCBs (polychlorinated biphenyls). Also included is a copy of the Federal Register section delineating these requirements. These regulations do affect us and PCB containing equipment must be disposed of only in an EPA approved manner, effective immediately. On Page 7157 of the Federal Register section attached it is stated that, "These regulations do not require removal of PCB's from service and disposal earlier than would normally be the case. However, when PCB's are removed from service and disposed of, disposal must be undertaken in accordance with these regulations."

Concerning the labeling of equipment containing PCBs, Page 7151 of the Federal Register states, "All containers of PCB liquids, not-in-service PCB transformers, and not-in-service large high voltage capacitors are required to be labeled by July 1, 1978. All transport vehicles carrying PCB's are required to be labeled beginning October 1, 1978. All in-service transformers, in-service large high voltage capacitors, and new equipment with small PCB capacitors are required to be labeled by January 1, 1979."

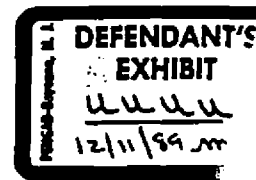
Please study the regulations concerning labeling and disposal carefully and comply with these regulations. I will write to EPA and inform them of the extent to which the regulations apply to NPC as "urged" in Mr. Eller's letter. If there are any problems, please call.

Rickie Slate
Rickie Slate

RS/mh

NE 13597

AD00276



Survey shows blacks' PCBs double those of whites

Newsday

WASHINGTON — A national health survey shows that black Americans have twice as much of the dangerous chemical compounds called PCBs in their bodies as whites.

The survey, conducted by the Environmental Protection Agency, is not yet published. But Dr. Frederick W. Kutz, who is in charge of the EPA's national monitoring program for pesticide residues in human beings, told Newsday that the results are "absolutely a representative sample" of the U.S. population as a whole. "We don't know why," Kutz of the finding. "We just know it's occurring."

The survey results, based on a weighted population sample of 10,000 persons by census tract across the country, show that blacks have an average of about four parts per million of PCBs, or polychlorinated biphenyls, stored in their bodies, compared to two parts per million in whites. Although those seem like small amounts, the compounds are considered so dangerous in both short- and long-term effects on human beings — concentrations as low as 10 parts per million can have harmful effects — that the EPA's findings have caused a strong reaction among black political leaders and members of the health community.

These were some immediate reactions to a request from Newsday for comment on the findings:

—The Congressional Black Caucus designated Rep. Parren J. Mitchell, D-Md., to press the environmental agency for answers on what should be done "to reduce high levels in blacks and the poor and to determine what long-range measures ought to be initiated to prevent overexposure of poor, blacks and minorities" to PCBs.

—New York State Health Commissioner David Axelrod said his office will test milk samples already collected from nursing mothers to determine if there is a racial stratification in PCB levels. Axelrod also called on the EPA to perform or fund studies to determine the cause of high levels of the chemical in blacks. He expressed a "concern with infants particularly (because) an infant can get a very strong dose of this compound from

his mother."

—Medical leaders in both the National Association for the Advancement of Colored People and the all-black National Medical Association expressed concern. "I am going to present this to our health committee," said Dr. Sylvester Davis, chairman of NAACP's medical arm. "We will look into the situation and make any directed action which seems warranted." NMA President Jesse Barber, a neurosurgeon at Howard University Hospital, said his organization would investigate the EPA's findings to "see if there is anything we can do both from a scientific and a political point of view."

While the scientists as yet have no explanation for the difference between PCB levels in blacks and whites, they speculate that differences in diet, genetics or life-style, among other factors, might be responsible. An earlier study showing greater concentrations of the pesticide DDT in blacks than in whites was later attributed to a difference in exposure arising from life-style factors.

The precise level at which PCB concentrations are hazardous to human beings is unknown, but according to a Justice Department complaint in a recent case, "PCBs are toxic, carcinogenic and they bioaccumulate. At concentrations between 10 parts per million and 800 parts per million, they cause various harmful reactions in laboratory animals, including skin lesions, liver damage, kidney malfunction, ulceration of the stomach and reproductive failure; at levels greater than 800 parts per million death occurs in laboratory animals."

Because of the serious health hazards posed by PCBs, the Food and Drug Administration has established very low tolerances for PCBs in food items. Any items that exceed these tolerances are removed from the market. Among the items for which levels were established are eggs (0.5 part per million); dairy products (2.5 parts per million) and animal feed (0.2 part per million). Because PCBs are stored in fatty tissue, only fish and poultry, which have very little fat, are permitted higher concentrations; they may contain up to five parts per million.

Efforts by black political



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leaders in the health area have focused on problems such as providing minority health care and service, but the PCB study drew immediate reactions. "This area has been neglected and not concentrated on by the black community," said Rep. Louis Stokes, D-Ohio, chairman of the Black Caucus brain trust on health affairs. Another member, Dr. Nathaniel Revis, said he would recommend "that EPA or FDA further those studies by determining the effects of these high concentrations on disease processes—if there is a higher incidence of birth defects, tumors and liver disorders."

Harold Snyder, PCB regulation team leader at the environmental agency, said, "The human health hazards are obvious, PCBs are very persistent materials. They are a suspected carcinogen. We know they are associated with certain liver disorders."

But human evidence is slight and deals primarily with Japan, where 1,957 PCB poisoning cases have been recorded since 1968, from rice oil containing 800 to 1,000 parts per million of PCBs. Victims exhibited nervous disorders, hearing loss, visual impairment, birth defects and severe skin problems.

The evidence of the effects of PCBs on other forms of life, however, has been documented over a broad range of species. Although it is not known what the potential effects of four parts per million will be in black citizens, it is known it takes only 0.5 part per billion of PCB to kill salmon eggs. Pinfish, spot and other pan-sized fish are killed at five parts per billion.

At only 10 parts per billion or less, PCBs cause high mortality rates in Atlantic blue crabs, pink shrimp and oysters. The list goes on to include reproductive defects and other abnormalities in rats, chickens, and similar higher animal forms. As a result of those findings, Congress, in the Toxic Substances Control Act of 1976, ordered an end to the manufacture or sale of PCBs, effective this summer.

But that does not mean the problem will go away. The man-made compound is so stable that it is almost indestructible. It was developed for heat control within electrical systems. "It was super for this purpose because it wouldn't burn by

fire and it wouldn't degrade," even in acid, according to EPA's Snyder. And for that very reason, he said, "We are looking at the fact that now they are going to be around for 100 years or more" in the environment.

The EPA estimates the

total load of PCBs already dispersed in the U.S. environment at 150 million pounds; an additional 290 million pounds is buried in municipal landfills and 758 million more are currently in commercial use in power transformers and other electrical equipment such as air conditioners, microwave ovens and TV sets. Although EPA has regulations to control disposal of most of the PCBs now in commercial use, it cannot control disposal of smaller items such as TV sets, Snyder said.

The result is that something on the order of 500

million pounds of PCBs are expected to remain in the environment for at least a century. And the compound, as it is dispersed in water and soil, tends to move higher up the food chain to humans.

The EPA currently has no plans to allocate funds

for studying the PCB phenomenon, except for a cooperative effort with the Public Health Service in looking into nutritional effects on a broad range of diseases, which might discover a link between liver damage and PCB levels within the 7,000 people involved in that study.

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Toxic Substances



EPA's Final PCB Ban Rule:

Over 100
Questions & Answers
To Help You Meet
These Requirements

DEFENDANT'S
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PLAINTIFF'S
EXHIBIT

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INTRODUCTION

On May 31, 1979 in the Federal Register (44 FR 31514) the U.S. Environmental Protection Agency published the Final Rule for Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions. This Booklet* in a non-technical manner, deals with the Rule's coverage and requirements. Its question-and-answer format is categorized into the following 18 areas.

<u>Q&A Category</u>	<u>Questions</u>
Introductory Information	1-8
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*This Booklet has been prepared by the Industry Assistance Office within EPA's Office of Toxic Substances. It is an informal document, and persons are directed to the PCB Final Rule for specific legal requirements.

inks, lubricants, carbonless copy paper, and sealants, coatings, and dust control agents.

Most of the PCBs marketed in the United States are still in service, primarily in electrical equipment.

(6) WHY ARE PCBs HARMFUL TO HUMAN HEALTH AND THE ENVIRONMENT?

PCBs are harmful because once released into the environment they do not break apart into new chemical arrangements, instead they bioaccumulate in organisms throughout the environment. In addition, PCBs biomagnify in the food chain -- that is, they accumulate in the tissues of living organisms and as they move up the food chain towards man their concentration increases. These facts are significant because PCBs have been shown to cause chronic (long-term) toxic effects in many species even when the exposed to very low concentrations.

(7) WHAT ARE THE KNOWN HEALTH EFFECTS OF PCBs?

There are well documented tests which show PCBs cause, among other things, reproductive failures, gastric disorders, skin lesions, and tumors in laboratory animals.

Studies of workers exposed to PCBs have shown a number of symptoms and adverse effects including, but not limited to, chloracne and other epidermal disorders, digestive disturbances, jaundice, impotence, throat and respiratory irritations, and severe headaches.

(8) WHAT ACTION HAS EPA TAKEN AGAINST PCBs?

In 1976, Congress enacted the Toxic Substances Control Act (TSCA). Section 6(e) of this law requires EPA to establish rules to: (1) govern the disposal and marking of PCBs; and (2) prohibit, with certain exceptions, the manufacture, processing, distribution in commerce, and non-totally enclosed use of PCBs.

Final Marking and Disposal Rules appeared in the Federal Register on February 17, 1978 (clarifying amendments to this Rule appeared in the August 2, 1978 Federal Register).

On June 7, 1978, the Proposed PCB Ban Rule was published in the Federal Register. The Final PCB Ban Rule appeared in the Federal Register on May 31, 1979; this Rule supersedes the February 17, 1978 PCB regulation and takes effect on July 2, 1979.

one million additional pounds of existing PCBs will be controlled, as well as 100,000 to 500,000 pounds per year of new PCBs.

- (11) IS THERE ANYTHING WHICH CONTAINS LESS THAN 50 PPM PCBs WHICH IS BANNED FROM BEING USED UNDER THIS RULE?

Yes, waste oil containing any detectable concentration of PCBs is forbidden from being used as a sealant, coating, or dust control agent. To permit the use of waste oil with any PCB-contamination to be used in road oiling, pipe coating, or vegetation spraying would cause PCBs to directly enter the air and waterways, which could introduce them into the food chain.

- (12) WHAT IS THE DIFFERENCE BETWEEN "MANUFACTURING OF PCBs" AND "PROCESSING OF PCBs"?

The actual creation of the chemical substance PCB, or a substance contaminated with PCBs (e.g., PCBs as an impurity), is the "manufacturing of PCBs".

The production of PCB Articles and PCB Equipment is considered "processing of PCBs", and involves the use of existing PCBs. Processing PCBs includes such activities as placing manufactured PCBs into capacitors or transformers.

- (13) WHAT IS CONSIDERED A PCB ARTICLE? PCB EQUIPMENT? PCB ITEM?

An article whose surface is directly contacted by PCBs is considered a "PCB Article". Examples include capacitors, transformers, electric motors, pumps, and pipes.

Equipment whose surface is not directly contacted by PCBs, but contains a PCB article, is considered "PCB Equipment". Examples include televisions, air conditioners, microwave ovens, electronic equipment, and fluorescent light ballasts and fixtures.

"PCB Item" is a collective term used throughout the Rule to refer to PCB Equipment/Articles/Containers/Article Containers.

- (14) WHAT EFFECT DOES THE PCB BAN RULE HAVE ON PCB ARTICLES? PCB EQUIPMENT?

After July 2, 1979, PCB Articles can no longer be produced because the production is not totally enclosed. However, since

- (17) THE BAN RULE PROHIBITS THE USE OF PCBs EXCEPT IN A "TOTALLY ENCLOSED MANNER". WHAT IS MEANT BY "TOTALLY ENCLOSED MANNER?"

"Totally enclosed manner" is a term which Congress wrote into TSCA's Section 6(e) and refers to PCBs contained in a way that does not permit any detectable exposure to PCBs.

Examples of totally enclosed PCB uses, allowed to continue after July 2, 1979, are found in television sets, air conditioners, and microwave ovens. These items contain PCB components (such as PCB capacitors) but their normal continued use will not result in any exposure to human beings or their surroundings.

- (18) THE BAN RULE SAYS THAT EPA CAN GRANT EXCEPTIONS, KNOWN AS AUTHORIZATIONS, TO ENABLE THE CONTINUED MANUFACTURING, PROCESSING, DISTRIBUTION IN COMMERCE, OR USE OF PCBs IN A NON-TOTALLY ENCLOSED MANNER AFTER JULY 2, 1979. HOW CAN I GET AN AUTHORIZATION? HAS EPA ALREADY GRANTED SOME?

EPA may propose and grant an authorization without a specific request from those who will benefit from the authorization. Also, the authorization can be valid for any time period that EPA finds appropriate.

The following non-totally enclosed PCB activities have already been authorized by EPA (beside each is the Rule section to refer to for details):

- o servicing PCB Transformers and PCB-Contaminated Transformers (Sec. 761.31(a));
- o use in and servicing of Railroad Transformers (Sec. 761.31(b));
- o use in and servicing of Mining Equipment (Sec. 761.31(c));
- o use in Heat Transfer Systems (Sec. 761.31(d));
- o use in Hydraulic Systems (Sec. 761.31(e));
- o use in Carbonless Copy Paper (Sec. 761.31(f));
- o ^{USE IN} Pigments (Sec. 761.31(g));
- o servicing Electromagnets (Sec. 761.31(h));
- o use in Natural Gas Pipeline Compressors (Sec. 761.31(i));

IMPORT/EXPORT

- (22) CAN PCBs (THE CHEMICAL ITSELF) BE IMPORTED OR EXPORTED AFTER THE BAN RULE'S JULY 2, 1979 EFFECTIVE DATE? WHAT ABOUT PCB EQUIPMENT (TELEVISION SETS, MICROWAVE OVENS, ETC.) WHICH CAN CONTINUE TO BE DOMESTICALLY PRODUCED UNTIL JULY 1, 1979, HOW LONG CAN THEY CONTINUE TO BE IMPORTED AND EXPORTED?

Because TSCA considers the term "import" to be synonymous with "manufacture", no PCBs (except waste) can be imported or exported after July 2, 1979, unless an exemption is obtained from EPA.

Furthermore, it was the intent of Congress to have this Rule treat domestic and foreign PCB production equally. Therefore, PCB Equipment can be imported and exported until July 1, 1979. After July 1, 1979, an exemption must be obtained from EPA in order to continue this activity.

- (23) EPA HAS DECIDED TO ADOPT AN OPEN BORDER POLICY WITH RESPECT TO THE DISPOSAL OF PCBs. WHAT DOES THAT MEAN?

The PCB Ban Rule allows for PCB wastes to be either imported or exported for disposal for one year -- until May 1, 1980. All imported PCB wastes must be disposed of in accordance with Subpart B of the Final Rule. Persons exporting PCB wastes for disposal are to notify EPA at least 30 days before the first export shipment; quarterly reports of actual shipments are also required.

EPA believes that the adoption of this open border policy for PCB waste disposal will be advantageous to both the U.S. and foreign countries, especially Canada. Generators of PCB wastes will be able to select the PCB disposal site that offers the most reasonable transportation and disposal costs. The open border policy will be in effect for almost one year, at which time EPA will examine the progress made by other nations in establishing and operating safe PCB disposal sites. The Agency will also at this time determine if extension of the open border policy is appropriate.

requirements separately; the other 3 categories are discussed simultaneously.)

(27) HOW DO I DETERMINE WHICH OF THE FOUR TRANSFORMER CATEGORIES I HAVE?

A transformer must be assumed to be a PCB Transformer if: (1) the nameplate indicates that the transformer contains PCB dielectric fluid; (2) the owner or operator has any reason to believe that the transformer contains PCB dielectric fluid; or (3) the transformer's dielectric fluid has been tested and found to contain 500 ppm or greater PCB. If a transformer does not have a nameplate or there isn't any information to indicate the type of dielectric fluid in it, the transformer must be assumed to be a PCB Transformer.

If a transformer is tested and found to contain less than 500 ppm PCB, it will then fall into one of the other appropriate categories.

A transformer can be reclassified as a Non-PCB Transformer if its dielectric fluid has been tested or otherwise verified to contain less than 50 ppm PCB. Testing Transformers in order to classify them as Non-PCB Transformers does not significantly change the actions required by the Rule. If your transformers are proven Non-PCB Transformers you should take precautions to see that they aren't later contaminated during servicing with PCB fluid over 50 ppm.

(28) WHY SHOULD I ASSUME THAT MY MINERAL OIL TRANSFORMER IS A PCB-CONTAMINATED TRANSFORMER? IF I GO TO THE EXTRA TROUBLE AND EXPENSE TO TEST MY TRANSFORMER IN ORDER TO CLASSIFY IT AS A NON-PCB TRANSFORMER, WHY WON'T MY REQUIREMENTS UNDER THE RULE BECOME SIGNIFICANTLY SIMPLER?

Current data shows that 25-40% of the existing mineral oil transformers are contaminated with 50 ppm or more of PCBs.

No clear pattern exists to explain why one transformer is contaminated and another one is significantly less contaminated. This means that testing all transformers would be necessary in order to be certain about the appropriate category. This would be extremely expensive. Therefore, the requirements in the Rule for servicing, disposal, labeling, and use have been designed to make this testing step largely unnecessary.

The only servicing restriction on PCB-Contaminated Transformers is that companies servicing transformers owned by others and who sell PCB-contaminated mineral oil to their customers must

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use of most existing transformers throughout their lifetime. EPA has decided that this activity doesn't present an unreasonable risk to human health and the environment.

However, any servicing (including rebuilding) of PCB Transformers that involves removing the coils from the casing is prohibited by the Ban Rule. Removing the coils substantially increases PCB exposure, therefore, EPA concludes this servicing to be an unreasonable risk. EPA believes the cost of this prohibition (about \$14 million the first year and steadily less each year after) is justified by the increased risks which would otherwise occur to human health and the environment.

(32) CAN I REBUILD MY TRANSFORMERS?

Rebuilding a transformer would involve one or more of the following: draining the transformer, removing and disassembling the core, reworking the coil or rewinding a new coil, reassembling the core, and refilling the transformer with new fluid.

EPA permits the rebuilding only of PCB-Contaminated Transformers (containing between 50 ppm and 500 ppm PCB), and, of course, Non-PCB Transformers. If your transformer is classified as a PCB Transformer (containing 500 ppm or greater PCB), it cannot be rebuilt unless it is first reclassified to a PCB-Contaminated Transformer.

EPA decided to permit rebuilding of PCB-Contaminated Transformers, because the exposure to PCB is relatively low and the economic impact of not permitting this activity would be very high.

(33) CAN I SERVICE MY OWN TRANSFORMERS?

EPA has decided to authorize this activity, which is considered use, for persons who service their own transformers until July 1, 1984.

(34) CAN I HAVE A SERVICE SHOP WORK ON MY TRANSFORMER?

Yes, you can have work done on your transformer without receiving an exemption from EPA provided the shop does not add any PCB fluid. If PCB fluid (50 ppm PCB or greater) needs to be added, the shop can add your fluid without obtaining an exemption. However, if the service shop adds their PCB fluid to your transformer, they must get an exemption to do so after July 1, 1979.

able to use a Railroad Transformer containing greater than 1,000 ppm PCB after July 1, 1984.

(45) DO I HAVE TO TEST MY RAILROAD TRANSFORMER?

You will have to test your Railroad Transformers immediately after any PCB concentration reduction related servicing, AND AGAIN BETWEEN 12 AND 24 MONTHS AFTER SUCH SERVICING.

(46) HOW OFTEN DO I HAVE TO TEST MY RAILROAD TRANSFORMER?

It is necessary to test your Railroad Transformer immediately after it has been serviced to reduce the PCB concentrations in order to verify the new PCB concentration. In addition, between 12 and 24 months after such servicing the transformer is to be tested again to gauge the PCB concentration level.

(47) ARE THERE RESTRICTIONS ON WHAT I PUT IN MY RAILROAD TRANSFORMER?

Yes, there are restrictions. If you rebuild (remove the coil) the Transformer after January 1, 1982 it cannot be refilled with dielectric fluid containing a PCB concentration greater than 50 ppm. After January 1, 1982, Railroad Transformers may only be serviced with dielectric fluid containing less than 60,000 ppm PCB. Finally, after January 1, 1984, Railroad Transformers may only be serviced with dielectric fluid containing less than 1000 ppm.

(48) WHAT KIND OF SERVICING CAN BE DONE ON RAILROAD TRANSFORMERS?

Any kind of servicing can be done on Railroad Transformers until January 1, 1982. After that time, the transformer can be rebuilt only if it is to be refilled with dielectric fluid containing less than 50 ppm PCB. Starting on January 1, 1982 transformers may only be serviced with dielectric fluid containing less than 60,000 ppm PCB (except when it has been rebuilt). After January 1, 1984, Railroad Transformers may only be serviced with dielectric fluid containing less than 1000 ppm PCB (except when it has been rebuilt).

After July 1, 1979, processing and distribution in commerce of PCBs in order to service Railroad Transformers can be conducted only by those persons granted an exemption.

(49) CAN I REBUILD MY RAILROAD TRANSFORMER?

Before January 1, 1982 you can rebuild your Railroad Transformer with PCB dielectric fluid. After January 1, 1982, any rebuilt Railroad Transformers must not contain dielectric fluid with a PCB concentration greater than 50 ppm.

CAPACITORS

(50) HOW DO THESE RULES AFFECT CAPACITORS? CAN I CONTINUE TO USE MY PCB CAPACITORS?

Yes, you can continue to use your PCB capacitors for their useful life. The primary effect of the new prohibition rules is to terminate the manufacture of any new PCB capacitors.

(51) WHAT ABOUT THE DISPOSAL OF PCB CAPACITORS?

These rules continue the provisions of the PCB Disposal and Marking Rule published in the February 17, 1978 Federal Register. Large PCB capacitors must be disposed of in an EPA approved chemical waste landfill or incinerator. After January 1, 1980 all large PCB capacitors will have to be incinerated in special EPA approved incinerators.

Special disposal is not required for small capacitors --- except those waste capacitors owned by PCB capacitor or PCB equipment producers.

(52) WHAT IS THE DIFFERENCE BETWEEN LARGE AND SMALL CAPACITORS?

Small capacitors have less than 3 pounds of contained dielectric fluid; large capacitors have 3 pounds or more of dielectric fluid.

(53) I HAVE PCB CAPACITORS THAT ARE TEMPORARILY OUT OF SERVICE; CAN THEY BE PUT BACK INTO SERVICE?

Yes, but they will be subject to disposal requirements at a later date.

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(59) CAN I SCRAP THESE MACHINES?

Yes, but first the PCB motors must be removed and properly disposed. PCB motors can either be incinerated or, after draining the PCBs, placed in a chemical waste landfill.

(60) HOW LONG CAN I USE THESE MACHINES?

PCBs cannot be used in mining equipment after January 1, 1982.

HYDRAULIC SYSTEMS

(61) DO ALL HYDRAULIC SYSTEMS HAVE PCBs IN THEM?

Probably not. PCB hydraulic fluid was developed for use in machines that were subject to high temperatures, such as aluminum die casting machines and hydraulic machines in steel mills. Because of their low flammability, PCBs provide an extra measure of fire protection. The use of these high concentration fluids was discontinued several years ago by most users, because of serious water pollution problems. However, residues of the original fluid remain in sufficient quantities to be of continuing environmental concern.

In addition, it is possible that hydraulic systems on other machines that did not pose any special fire risk also had these PCB fluids added to them. These may be sufficiently contaminated to require action under these regulations.

(62) CAN THESE PCB CONTAMINATED HYDRAULIC SYSTEMS CONTINUE TO BE USED? IS ANY CORRECTIVE ACTION NECESSARY?

These PCB contaminated systems can be used until July 1, 1984, provided that a corrective program of testing, draining, refilling, and/or topping-off is undertaken.

(63) HOW OFTEN MUST I TEST MY HYDRAULIC SYSTEM?

Any hydraulic system that ever contained PCB hydraulic fluid must be tested by November 1, 1979, and, at least annually thereafter, until the system reaches 50 ppm PCB.

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- (69) CAN PCB CONTINUE TO BE USED IN SMALL QUANTITIES FOR RESEARCH AND DEVELOPMENT?

Yes, until July 1, 1984. As with microscopic slides, EPA will decide later whether to extend the authorized time for use.

- (70) IN THE EARLY 1970's CARBONLESS COPY PAPER WAS MADE WITH INK CONTAINING PCBs. WHAT PROVISIONS DOES THE PCB BAN RULE MAKE FOR THIS PAPER?

Although carbonless copy paper is no longer made with PCBs, supplies of this paperstock still exists; most are in files. Because the amount of PCB on each sheet is extremely small and no inexpensive method of separating PCB from non-PCB carbonless paper has been developed, EPA has authorized the use of existing PCB carbonless copy paper indefinitely.

- (71) SOME PIGMENTS CONTAIN PCBs, CAN THEY CONTINUE TO BE USED?

EPA's PCB Ban Rule authorizes the use of diarylide and phthalocyanine pigments, containing PCBs as an impurity in concentrations ranging from several thousand parts per million to 50 ppm, until January 1, 1982. However, after July 2, 1979, these pigments, containing greater than 50 ppm PCB, cannot be manufactured, and they cannot be processed or distributed in commerce after July 1, 1979, unless EPA grants exemptions for these activities.

- (72) OTHER CHEMICALS ALSO CONTAIN PCBs IN LOW CONCENTRATIONS, CAN THEY CONTINUE TO BE USED?

At this time, EPA's Ban Rule does not authorize the use of any other chemicals containing PCBs. Several manufacturers have requested exemptions to manufacture chemicals with low concentrations of PCBs, and, if these exemptions are granted, EPA will consider appropriate authorizations to permit the use of the chemicals.

- (73) IF SOMEONE MANUFACTURES PCB CONTAMINATED CHEMICALS BUT DID NOT APPLY TO EPA FOR AN EXEMPTION CAN THEY STILL REQUEST ONE?

Anyone in that situation should apply to EPA for an exemption using the procedures EPA published in the Federal Register on November 1, 1978. (See the "Contacts for Infor-

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extremely high (approximately \$10 for each of the 35 million transformers).

An unmarked transformer is automatically assumed to be a PCB-Contaminated Transformer. However, if a transformer has no nameplate information but there is a reasonable suspicion that PCBs may be present above 500 ppm --- the transformer should be labeled as a PCB Transformer until the PCB content can be verified.

(78) WHERE DO I HAVE TO PUT THE LABELS?

All labels (or marks) are to be put on the exterior of PCB Items and transport vehicles in a place that they can be easily seen and read by anyone inspecting or servicing them.

(79) THERE ARE A LOT OF PCB CAPACITORS AND EQUIPMENT CONTAINING THESE CAPACITORS IN USE. DO THEY ALL HAVE TO BE LABELED?

The requirements for labeling capacitors are primarily related to disposal; the labels serve as a positive reminder regarding disposal. All large, high voltage PCB capacitors have to be labeled, including those in service. Large, low voltage capacitors have to be labeled when they are taken out of service for disposal.

Small capacitors do not have to be labeled. Equipment containing PCB capacitors does not have to be labeled unless the capacitor is a large, high voltage type or if the equipment was produced after January 1, 1979 and contains a small PCB capacitor.

(80) DO I HAVE TO LABEL A PCB CAPACITOR THAT IS ON A POLE OR IN A SIMILAR INACCESSIBLE LOCATION?

If a PCB capacitor is installed in a "protected" area (e.g., on a power pole, or structure, or behind a fence) the pole, structure, or fence is to be labeled in a place easily seen by interested persons, such as servicemen.

(81) I SUBMITTED A PETITION TO EPA TO BE GRANTED AN EXEMPTION FROM THE JULY 2, 1979 MANUFACTURING BAN. IF I AM GRANTED AN EXEMPTION, WHAT WILL THE LABELING REQUIREMENTS BE FOR THE PCBs I MANUFACTURE?

Any labeling requirements for chemical substances or mixtures containing 50 to 500 ppm PCBs manufactured after July 2,

(85) WHAT EQUIPMENT IS AVAILABLE TO DETECT PCBs?

There is no simple field test for detecting PCBs. It is usually done using gas chromatography/electron capture. The best solution would be to contact an experienced chemical laboratory in your area that could perform such tests.

(86) ARE THERE EPA APPROVED LABS TO ANALYZED SAMPLES OF PCBs?

No, EPA does not have a program for recommending or approving analytical laboratories.

STORAGE

(87) WHAT KINDS OF CONTAINERS ARE APPROPRIATE FOR STORAGE?

The May 31, 1979 Final Rule permits 5 container types (5, 5B, 6D, 17C and 17E) which comply with Department of Transportation (DOT) specifications set out in 49 CFR 173.346, to be used to store liquid PCBs. Most of industry already is using these containers for PCB storage and handling.

(88) CAN LARGE CONTAINERS, SUCH AS STORAGE TANKS, BE USED FOR THE STORAGE OF PCB LIQUIDS?

EPA decided in the Final Rule to permit large containers, such as storage tanks, to be used to store bulk PCB liquids. This is to allow safe transfer and storage of large PCB liquid quantities; in addition, reduce storage costs. In other words, the transfer of stored bulk PCBs from tanks to other tanks or tank trucks will lessen the spill risks as opposed to having to transfer these large quantities from a number of smaller storage drums into transfer tanks.

These storage tanks must meet design and construction standards adopted by OSHA (29 CFR 1910.106). Also the storage facilities must have a spill prevention control and counter measure plan similar to the plans required for oil spill prevention.

Owners and operators of bulk storage facilities will have to keep records of the amounts added to and removed from bulk containers. These records will be important in tracing waste shipments and enforcing the disposal and storage requirements.

When a container develops a leak, its contents should immediately be transferred to another, non-leaking container or to special "overpack" containers, such as those used in the chemical industry for leaking containers.

- (94) MUST THE EPA INSPECT A PCB STORAGE AREA ONCE IT IS BUILT BEFORE IT CAN BE USED?

No, it is the responsibility of the organization storing the PCBs to insure that the storage area meets the specifications.

- (95) DO PCB STORAGE AREAS HAVE TO BE PERIODICALLY CHECKED FOR LEAKS OR OTHER PROBLEMS? WHAT ABOUT PCB ARTICLES, SUCH AS TRANSFORMERS, THAT ARE IN SERVICE?

PCB storage areas must be checked by the owner or operators at least every 30 days. Articles in service are not required to be checked by the regulations, but periodic checks would be a wise practice.

SPILLS

- (96) DO PCB SPILLS HAVE TO BE REPORTED

Under the authority of TSCA, PCB spills have to be reported whenever the incident poses a substantial risk to human health or the environment. Since "substantial risk" cannot be precisely defined, however, any spill should be reported when people come into direct and uncontrolled contact with PCBs, or the extent of the spill is large enough to expose significant numbers of animals.

In addition, a spill should also be reported when the volume or the extent of the spill is unknown -- such as spills that enter drainage systems. PCB spills into water, onto shorelines, or those that threaten water-courses should always be immediately reported.

EPA is currently completing regulations under the Clean Air Act that will require reporting for water-related hazardous chemical spills (including PCBs). These regulations will have criminal penalties for failing to report such spills.

As a general rule, spills involving a single capacitor do not have to be reported unless PCBs threaten or enter a water-course. Because of the greater threat to health and the environment, transformer spills should be reported -- unless only

disposition. Specifically, this applies to facilities using or storing at least 99.4 pounds (45 kilograms) of PCBs in PCB Container(s); one or more PCB Transformers; or 50 or more PCB High or Low Voltage Large Capacitors.

These records shall be maintained for at least 5 years after the facility ceases using or storing PCBs or PCB Items in prescribed quantities.

(101) DO PCB INCINERATOR FACILITIES HAVE TO KEEP RECORDS?
CHEMICAL WASTE LANDFILL FACILITIES? HIGH EFFICIENCY BOILER
FACILITIES? IF SO, FOR HOW LONG?

Owners or operators of all three types of PCB Disposal Facilities have to keep records. Incinerator and high efficiency boiler facilities must keep their records for 5 years; chemical waste landfill facilities must keep their records for at least 20 years after PCBs have stopped being disposed there.

(102) WHEN MUST I BEGIN KEEPING RECORDS OF MY PCB FACILITIES?

PCB recordkeeping, if applicable, was to have begun on July 2, 1978. These records form the basis of an annual document prepared for each facility by July 1; the first annual reports should be compiled by July 2, 1979.

(103) MUST COMPANIES SEND THEIR ANNUAL REPORTS CONCERNING PCBs TO
EPA OR KEEP THEM FOR THEIR OWN RECORDS?

Companies should keep their PCB records and annual reports at their facility for inspection by EPA personnel. Do not send the records or reports to EPA unless it is specifically requested by the Agency.

(104) I HAVE PCB FACILITIES IN SEVERAL LOCATIONS. DO RECORDS
HAVE TO BE KEPT AT EACH SITE?

Owners or operators of more than one facility having PCBs may choose to keep all of the records at a single facility, but the identify of that single facility must be available at each location. The record location must be manned at least 8 hours a day. ~~For A Normal 40 Hour Week~~

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(108) ARE THERE SPECIAL DISPOSAL REQUIREMENTS FOR SMALL PCB CAPACITORS CONTAINED PRIMARILY IN SMALL APPLIANCES AND FLUORESCENT LIGHT BALLASTS?

No, small capacitors can be disposed of as municipal waste. EPA has determined that the random disposal of small capacitors in municipal solid waste sites by householders and other infrequent disposers does not present an environmental hazard.

However, the disposal of large quantities of small PCB capacitors by commercial and industrial activities poses a larger environmental risk. Therefore, EPA encourages these persons to establish voluntarily a collection and disposal program that would result in the waste capacitors going to chemical waste landfills or high temperature incinerators.

(109) HOW ARE HYDRAULIC MACHINES CONTAMINATED WITH PCBs TO BE DISPOSED?

In general, only a relatively small portion of these machines are contaminated with PCBs, in particular those used in die-casting and forging operations. Therefore, instead of requiring disposal in a chemical waste landfill, the final rule permits disposal of hydraulic systems as municipal solid waste and salvaging of these machines after draining. First, the machines must be drained of all free-flowing liquid. If the fluid contains more than 1000 ppm PCBs, the machine must be flushed with a solvent and thoroughly drained before disposal. The liquid must be disposed of by high temperature incinerators or, if the PCB concentration is 50 to 500 ppm, by high efficiency boilers or in chemical waste landfills.

(110) HOW CAN I DISPOSE OF THE DIELECTRIC FLUID IN MY TRANSFORMER?

Fluids from PCB Transformers (concentrations of 500 ppm greater) must be disposed of only by high temperature incineration. Fluids from PCB-Contaminated Transformers (with 50 ppm to 500 ppm PCBs) must be disposed of in high efficiency boilers, in approved chemical waste landfills, or in high temperature incinerators. Fluids from Non-PCB Transformers (with less than 50 ppm PCBs) have one disposal restriction: they cannot be used as a sealant, coating, or dust control agent if they contain any detectable PCB.

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(117) HAVE ... DISPOSAL SITES BEEN APPROVED FOR PCBs? WHERE ARE THEY?

Yes, ^{seven} ~~eight~~ chemical waste landfill sites have been approved. No incinerator sites have yet been approved, but three sites are currently being considered. AND ONE LIMITED USE INCINERATOR

The landfill locations are as follows:

1. Facility: General Electric Co., Silicone Products Division. Facility Address: 260 Hudson River Rd., Waterford, New York 12189. Facility Telephone Number (518) 237-3330. Type of Facility Approved: Incinerator. Type of PCB Waste Handled: Approval allows G.E. to incinerate only those PCB wastes which are generated on site, i.e., G. E. can not accept PCBs for incineration from any other company or any other G.E. facility. Expiration Date of Approval: September 1, 1981. EPA Regional Office Contact: Wayne Pierre. EPA Telephone Number: (212) 264-0505.
2. Facility: Newco Chemical Waste Systems, Inc. Facility Address: 4526 Royal Avenue, Niagara Falls, New York 14330. Facility Telephone Number: (716) 285-6944. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums). Expiration Date of Approval: August 18, 1981. EPA Regional Office Contact: Wayne Pierre. EPA Telephone Number: (212) 264-0505.
3. Facility: SCA Chemical Services, Inc. Facility Address: 1550 Balmer Rd., Model City, New York 14107. Facility Telephone Number: (716) 754-8231. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums). Expiration Date of Approval: October 2, 1981.
4. Facility: Waste Management of Alabama, Inc. Facility Address: P.O. Box 1200 Livingston, Alabama 35470. Facility Telephone Number: (205) 652-9529. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soils, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums). Expiration Date of Approval: Open-ended. EPA Regional Office Contact: Mr. James Scarbrough. EPA Telephone Number (404) 881-3016.
5. Facility: Casmalia Disposal. Facility Address: 539 Ysidro Rd., P.O. Box 5275, Santa Barbara, California 93108-main office (site located near Casmalia in Santa Barbara County). Facility Telephone Number: (805) 969-4703. Type of Facility Approved:

(119) CAN PCBs OR PCB ITEMS BE EXPORTED FOR DISPOSAL? BE IMPORTED FOR DISPOSAL?

Yes, refer to Question #23 in the "Import/Export" section of this Booklet.

PCBs IN THE WORKPLACE

(120) ARE THERE ANY OSHA RULES GOVERNING PCBs IN THE WORKPLACE?

~~YES THERE ARE OSHA REGULATIONS GOVERNING PCBs IN THE WORKPLACE~~

~~No, not at the present time;~~ however, in 1977 the National Institute of Occupational Safety and Health (NIOSH) -- the HEW organization responsible for researching workplace safety -- published "Criteria for a Recommended Standard ... Occupational Exposure to Polychlorinated Biphenyls (PCBs)". OSHA, associated with the Department of Labor, will use this document to develop mandatory standards regarding PCBs. ~~HOWEVER OSHA ACT REQUIRES EMPLOYERS TO PROVIDE EMPLOYEES WITH A PLACE OF EMPLOYMENT THAT IS FREE FROM RECOGNIZED HAZARDS.~~

(121) WHAT IS A RECOMMENDED STANDARD FOR OCCUPATIONAL EXPOSURE? WHAT IS THE STANDARD RECOMMENDED BY NIOSH FOR OCCUPATIONAL EXPOSURE TO PCBs?

A recommended standard is a determination of the level of exposure that will substantially reduce any risks of reproductive or tumorigenic effects of PCBs and prevent other adverse effects of exposure in the workplace. It is based on a 10-hour workday, 40-hour workweek, over a normal working lifetime.

NIOSH has recommended in their Criteria Document for PCBs that occupational exposure to PCBs be controlled so that no worker is exposed at a concentration greater than 1.0 microgram total PCBs per cubic meter of air (1.0 Mg/cu m), determination as time-weighted average (TWA) concentration, for up to a 10-hour workday, 40 hour workweek. This is only a recommended standard and it has not been adopted to date, by either OSHA or EPA. At the present time, however, OSHA is reviewing this recommended standard.

(122) DID NIOSH RECOMMEND ANYTHING ELSE TO REDUCE EXPOSURE TO PCBs IN THE WORKPLACE?

Yes, NIOSH made recommendations about work practices, personal protective equipment and clothing, medical surveillance, personal clean up and sanitation practices, and employee information programs.

A000257

NW12998

(125) IF I GET A LIQUID ON MY SKIN, HOW CAN I REMOVE IT?

If liquid or solid PCBs are splashed or spilled on an employee, contaminated clothing should be removed promptly and the skin washed thoroughly with soap and water for at least 15 minutes.

Eyes should be irrigated for at least 15 minutes if liquid or solid PCBs get into them. A drop of vegetable oil may be put into the eye to relieve the irritating effect of PCBs.

CONTACTS FOR INFORMATION

(126) IF I HAVE OTHER QUESTIONS ABOUT THE PCB BAN RULE'S PROVISIONS, IS THERE SOMEONE I CAN CONTACT?

If you have more questions call the Industry Assistance Office on their nationwide toll free number: 800-424-9065; persons in the Washington, D.C. area can reach this Office by calling 554-1404.

(127) HOW DO I GET A COPY OF THE RULE? SUPPORT DOCUMENT/ VOLUNTARY ENVIRONMENTAL IMPACT STATEMENT (REFERRED TO IN THE RULES AS THE VERSAR REPORT)?

Copies of both can be obtained by calling the phone numbers mentioned in the answer to Question 126, or by writing to:

John B. Ritch, Jr., Director
Industry Assistance Office
Office of Toxic Substances (TS-799)
U.S. Environmental Protection Agency
401 "M" Street, S.W.
Washington, D.C. 20460

Tests to determine extent

Sunday, September 16, 1979—Las Vegas Review-Journal—15A

of PCB poisoning

SALT LAKE CITY (AP) — Blood tests and possibly breast milk samples will be taken this week by scientists seeking to determine how widely the toxic substance PCB has spread through Western states, officials said Saturday.

Researchers from the national Center for Disease Control are expected to arrive in eastern Idaho early in the week to help state officials with the tests for PCB, an outlawed chemical which so far has been found in food or feed in nine states.

Health officials have found PCB contamination in chickens, eggs, processed foods and feeds in Idaho, Utah, Montana, Washington, Oregon, Iowa, North Dakota, South Dakota and Minnesota, said Leroy Gomez, district director for the Food and Drug Administration in Denver.

Dr. Edward Gallagher, state health officer for the Idaho Department of Health, said Saturday blood tests and possibly breast milk samples would be taken this week in eastern Idaho's Franklin County.

Gallagher said researchers would be looking for the amount of PCB individuals may have ingested. He said the tests would determine whether further health studies would be needed.

Contamination was recently noticed at Ritewood Eggs Co. in Franklin, Idaho, a major egg supplier voluntarily destroying millions of eggs and hundreds of thousands of chickens.

So far, no illness in humans or animals has been traced to PCB contamination, Gallagher said. He said because

calculated levels of the chemical in contaminated eggs was so low, a person would have to eat "a tremendous number of eggs" to show any ill effects.

Contact with large amounts of PCB — polychlorinated biphenyl — has caused tumors in laboratory animals, killed cattle in Kansas and caused skin diseases among humans, scientists say.

Gomez said FDA and Environmental Protection Agency investigators were sampling meal at Pierce Packing Co. plant in Billings, Mont., thought to be a source of the contamination.

Gomez said meal made from hog byproducts shipped by Pierce beginning in early June contained the synthetic chemical, once used as a coolant in electrical equipment

but banned five years ago.

Still not known is how the chemical may have gotten into the meal.

Chickens from Ritewood were shipped to Utah for slaughter, then to Clinton, Iowa, where they were to be put in Swift & Co. meat pies, until contamination was discovered.

Contaminated chickens from Montana were sent to Butterfield, Minn., to be put into Campbell's chicken soup, but the contamination was found before the soup was packaged.

Eggs from chickens fed bone and meat meal containing PCB went into 75,000 Pepperidge Farms frozen cakes, which have been quarantined.

Farmers in Utah and Idaho have voluntarily destroyed 350,000 chickens in Utah and Idaho, Gomez said.

A000259



September 26, 1979

Chief Dale Star
City of Henderson Fire Dept.
134 Atlantic Street
Henderson, NV 89015

Subject: Polychlorinated Biphenyls

Dear Chief Star:

The U.S. Environmental Protection Agency has notified the Electric Utility Industry that a group of chemicals known as polychlorinated biphenyls (PCB's) represents a potential hazard to the environment and to human health.

Nevada Power Company is committed to maintain environment policies which recognize that our facilities and operations must be conducted and operated within environmental requirements. The Toxic Substance Control Act is one of such federal regulations which prescribes the requirements for the collecting, handling, transportation, and disposal of Polychlorinated Biphenyls or PCB's.

PCB's are used as an additive in insulating fluids and are found in some capacitors and indoor transformers. Until recently PCB's were added to certain transformers and capacitors because PCB's can reduce the likelihood of fire in electric equipment.

In compliance with current regulations all of our indoor and outdoor electrical equipment (transformers and pole mounted capacitors) containing PCB fluid have been identified and have appropriate labeling.

Occasionally our pole mounted capacitors will fail and rupture releasing approximately 1-2 gallons of the fluid, and pole top fires can result. If such an event occurs and your engine Companies respond, we would appreciate your cooperation and mutual assistance in the following:

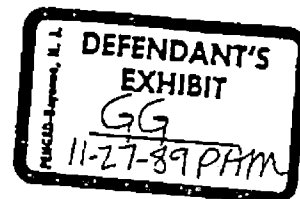
- (1) Immediately notify the Power Company at 385-5691.
- (2) Under no circumstances is water to be used in washing down. It is essential that the cleanup be conducted at the site in a manner least likely to spread the contamination.
- (3) Exception - In the event of a pole top fire in order to protect life, fire control, or protecting exposures, water may be used to the extent to provide that protection.



0000260
N 06784

September 26, 1979

Chief Sam Cooper
City of Las Vegas
Fire Department
P. O. Box 510
Las Vegas, NV 89101



Subject: Polychlorinated Biphenyls

Dear Chief Cooper:

The U.S. Environmental Protection Agency has notified the Electric Utility Industry that a group of chemicals known as polychlorinated biphenyls (PCB's) represents a potential hazard to the environment and to human health.

Nevada Power Company is committed to maintain environment policies which recognize that our facilities and operations must be conducted and operated within environmental requirements. The Toxic Substance Control Act is one of such federal regulations which prescribes the requirements for the collecting, handling, transportation, and disposal of Polychlorinated Biphenyls or PCB's.

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- (3) Exception - In the event of a pole top fire in order to protect life, fire control, or protecting exposures, water may be used to the extent to provide that protection.

N 05917

A000261

- (4) Avoid contamination of Fire service equipment or personnel. Avoid walking, dragging hoses, or contacting any surfaces contaminated by the PCB fluid.

The Company will respond on notice or discovery and will undertake cleanup and decontamination. Company representatives will also contact the affected public and advise them of the incident and what steps are being taken to insure their safety and health. Should you have any questions concerning this request, I may be reached at 385-5627.

As in the past, the Company appreciates the Fire Department's continuing cooperation and mutual assistance.

Please continue to promptly notify the Power Company in all electrical emergencies involving our facilities.

Sincerely,

Donald G. Fabbi
Donald G. Fabbi
Safety Director

DGF/jg

N 05918

A000262



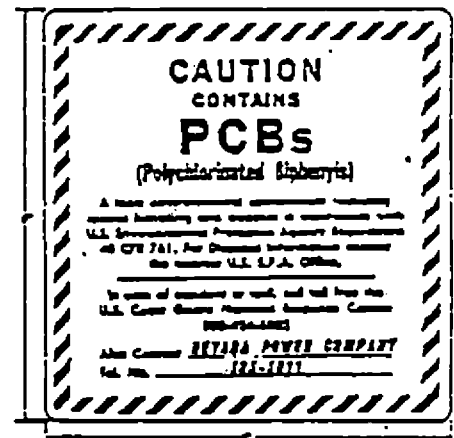
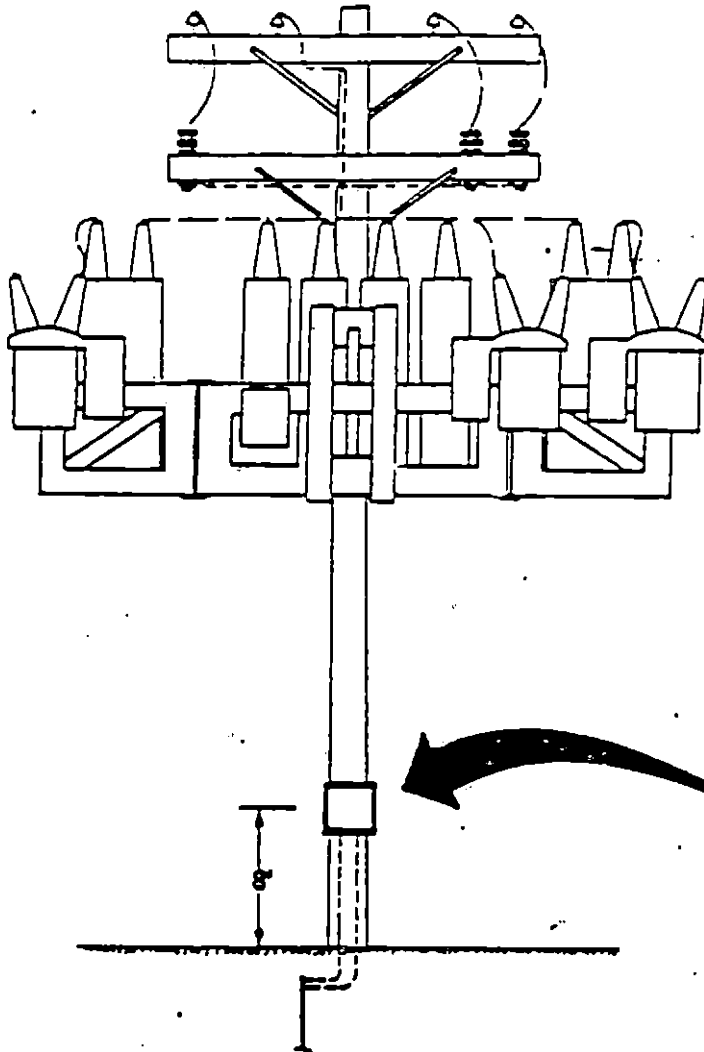
PCBs

Polychlorinated Biphenyls

CONTROL & HANDLING PROCEDURES

SUBJECT:

Labeling - High Voltage Capacitor Pole Locations



CHG	DATE	DESCRIPTION	APPR'D	CHG	DATE	DESCRIPTION	DATE
DRAWN BY: <i>607</i>		PCB LABELING NEVADA POWER COMPANY LAS VEGAS, NEVADA				SUPERSEDES	
CHECKED:						SUPERSEDED BY:	
APPROVED:						SHEET NO. of SHTS	
APPROVED:						DRAWING NO. CHANGE	
DATE	SIZE						
6-78	—						
Originated By: D. Fabbri			Approved By: J. McCarthy			Page 9	
Date: 3/15/79			Date: 7/10/79				

N 05919

A000263

September 26, 1979

Chief Kimball
City of North Las Vegas
Fire Department
2626 E. Carey Avenue
North Las Vegas, Nevada 89030

Subject: Polychlorinated Biphenyls

Dear Chief Kimball:

The U.S. Environmental Protection Agency has notified the Electric Utility Industry that a group of chemicals known as polychlorinated biphenyls (PCB's) represents a potential hazard to the environment and to human health.

Nevada power Company is committed to maintain environment policies which recognize that our facilities and operations must be conducted and operated within environmental requirements. The Toxic Substance Control Act is one of such federal regulations which prescribes the requirements for the collecting, handling, transportation, and disposal of Polychlorinated Biphenyls or PCB's.

PCB's are used as an additive in insulating fluids and are found in some capacitors and indoor transformers. Until recently PCB's were added to certain transformers and capacitors because PCB's can reduce the likelihood of fire in electric equipment.

In compliance with current regulations all of our indoor and outdoor electrical equipment (transformers and pole mounted capacitors) containing PCB fluid have been identified and have appropriate labeling.

Occasionally our pole mounted capacitors will fail and rupture releasing approximately 1-2 gallons of the fluid, and pole top fires can result. If such an event occurs and your engine Companies respond, we would appreciate your cooperation and mutual assistance in the following:

- (1) Immediately notify the Power Company at 385-5691.
- (2) Under no circumstances is water to be used in washing down. It is essential that the cleanup be conducted at the site in a manner least likely to spread the contamination.
- (3) Exception - In the event of a pole top fire in order to protect life, fire control, or protecting exposures, water may be used to the extent to provide that protection.

A000264

N 06780

- (4) Avoid contamination of Fire service equipment or personnel. Avoid walking, dragging hoses, or contacting any surfaces contaminated by the PCB fluid.)

The Company will respond on notice or discovery and will undertake cleanup and decontamination. Company representatives will also contact the affected public and advise them of the incident and what steps are being taken to insure their safety and health.

As in the past, the Company appreciates the Fire Department's continuing cooperation and mutual assistance.

Please continue to promptly notify the Power Company in all electrical emergencies involving our facilities.

Sincerely,

Donald G. Fabbi

Donald G. Fabbi
Safety Director

DGF/jg

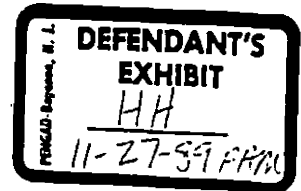
A000265

N 06781

NEVADA POWER COMPANY
FOUR STREET AND STEWAR AVENUE
P.O. BOX 230 • LAS VEGAS, NEVADA • 89151

September 26, 1979

Chief Roy L. Parrish
Clark County Fire Dept.
707 E. Desert Inn Road
Las Vegas, NV 89109



Subject: Polychlorinated Biphenyls

Dear Chief Parrish:

The U.S. Environmental Protection Agency has notified the Electric Utility Industry that a group of chemicals known as polychlorinated biphenyls (PCB's) represents a potential hazard to the environment and to human health.

Nevada Power Company is committed to maintain environment policies which recognize that our facilities and operations must be conducted and operated within environmental requirements. The Toxic Substance Control Act is one of such federal regulations which prescribes the requirements for the collecting, handling, transportation, and disposal of Polychlorinated Biphenyls or PCB's.

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- (1) Immediately notify the Power Company at 385-5691.
- (2) Under no circumstances is water to be used in washing down. It is essential that the cleanup be conducted at the site in a manner least likely to spread the contamination.
- (3) Exception, - In the event of a pole top fire in order to protect life, fire control, or protecting exposures, water may be used to the extent to provide that protection.

A000266

N 06778

- (4) Avoid contamination of Fire service equipment or personnel. Avoid walking, dragging hoses, or contacting any surfaces contaminated by the PCB fluid.

The Company will respond on notice or discovery and will undertake cleanup and decontamination. Company representatives will also contact the affected public and advise them of the incident and what steps are being taken to insure their safety and health. Should you have any questions concerning this request, I may be reached at 385-5627.

As in the past, the Company appreciates the Fire Department's continuing cooperation and mutual assistance.

Please continue to promptly notify the Power Company in all electrical emergencies involving our facilities.

Sincerely,

Donald G. Fabbi
Donald G. Fabbi
Safety Director

DGF/jg

N 06779

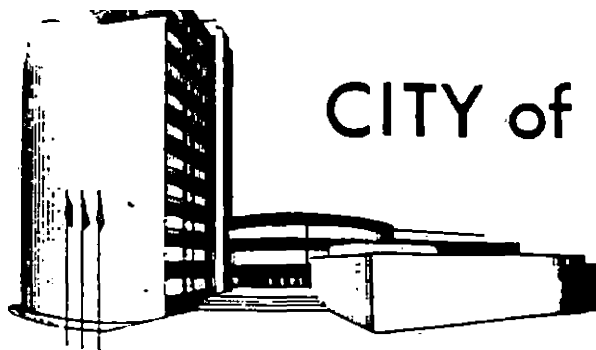
A000267

MAYOR BILL BRIARE

COMMISSIONERS
PAUL J. CHRISTENSEN
RON LURIE
AL LEVY
ROY WOOFER

CITY ATTORNEY
RICHARD C. MAURER

CITY MANAGER
RUSSELL DORN



CITY of LAS VEGAS

October 5, 1979

Mr. Donald G. Fabbi, Safety Director
Nevada Power Company
Fourth Street and Stewart Avenue
Las Vegas, Nevada

Dear Mr. Fabbi:

Thank you for your informative letter on polychlorinated biphenyls.

We have sent a copy of your letter and diagrams out to all our firefighters. They will familiarize themselves with this information and take appropriate action in any situation involving this substance.

Sincerely,

Sam Cooper, Fire Chief
Las Vegas Fire Department

SC:rh

A000268



PCB contamination

woes grow

Friday, October 12, 1979—Las Vegas Review-Journal—5C

The Los Angeles Times
WASHINGTON —
Harris Dwight Ladle is an anguished man.

Some days as many as 15 of the mink on his Provo, Utah, farm die, the victims of a Montana-generated contamination of the chemical PCB that federal agents are investigating from California to New Jersey.

The government already has taken some of the blame for the troubles that have befallen Ladle and others like him. And, faced with reports of contamination from 17 states, federal authorities readily admit the seriousness of the situation.

"This is one of the largest chemical contamination incidents ever reported to us," said Anthony Celeste, an associate director of the Food and Drug Administration and head of the federal investigation. "In terms of the number of states affected it is the most widespread."

It all started in a small way last June — with the single leak of 200 gallons of PCB — polychlorinated biphenyl — from a spare, unused electrical transformer at the Pierce Packing Co., a hog slaughtering and feed plant in Billings, Mont.

(PCBs belong to a family of organic chemicals known as polychlorinated hydrocarbons. They are virtually indestructible and almost all those in existence have been manufactured by man. PCBs accumulate in body tissue and are poisonous for man and other animals.)

As a result of the Billings leak, highly contaminated feed from Pierce has been eaten by many chickens and hogs in the West.

Contaminated chickens, eggs and hogs have been found in a number of states, particularly in the Rocky Mountain area. Furthermore, millions of pounds of grease for use in the manufacture of soap and cosmetics, have been shipped from the Billings plant to California and Washington State and as far away as Canada and Japan.

The latest incident, one of a series of PCB contaminations in this decade, raises bothersome questions about the ubiquitous quality of toxic chemicals like PCB, about the ability of federal officials to move quickly to deal with the problem, and about the willingness of federal agencies to alert consumers.

Gov. John V. Evans of Idaho, a state where more than 400,000 chickens and millions of eggs have been destroyed because of PCB contamination, denounces "inexcusable delays" by the Department of Agriculture and the Food and Drug Administration in reporting the discovery of such contaminations. Ev-

ans is especially critical of an unnamed FDA official whom he quoted as saying: "We didn't want to create a panic."

This attitude also touches a raw nerve in Ladle, the Utah mink farmer. "They won't tell the sheep because they might run," he said, "but the wolf's already in among them killing the flock."

It was only a few weeks ago that Ladle learned that feed contaminated by PCB was responsible for killing more than a quarter of his 1,500 mink.

He had been giving his mink feed mixed with viscera from PCB-contaminated chickens.

Ladle is upset at what he sees as the government's delay in finding and reporting the contamination. Had the contamination been discovered earlier, he feels, he could have stopped using the tainted viscera — and he could have saved himself a lot of worry and money trying to find out what was killing his mink.

In a statement before a House commerce subcommittee on Sept. 28, Carol Tucker Foreman, assistant secretary of agriculture for food and consumer services acknowledged that there had been "some initial delays" in reporting the contamination.

As pieced together by federal agents, PCB-contaminated feed moved from the Billings plant to the Ritewood Farms in Franklin, Idaho, on June 25. An Agriculture Department inspector, performing a routine chore, then took a tissue sample from a Ritewood Farms chicken that was processed at the Jolley Wholesale Poultry processing plant at Provo, Utah, on July 6.

Because of a mix-up attributed to employee vacations, the sample was not sent by mail from the Provo plant to the Agriculture Department's San Francisco laboratory until July 16.

On Aug. 3, the Department's regional meat and poultry inspection office received test results indicating that the chicken had PCB residues of 15.65 parts per million, more than five times greater than the three parts per million allowed.

The regional office of the Department's Food Safety and Quality Service was notified five days later, and on Aug. 10 the department identified Ritewood Farms as the source of the contaminated chicken.

At this point, responsibility for the investigation passed from the Agriculture Department to the Food and Drug Administration. The Agriculture Department notified the FDA on Aug. 15, according to an official FDA chronology of events. On Aug. 20, the FDA began its investigation at Ritewood Farms.



CONTINUED ON OTHER SIDE

0000269
N 03187

CONTINUED

At this point, eggs and chickens from the massive farm, one of the West's leading egg producers, were still entering the market place.

After many days of investigation, Ritewood Farms owner Marlow Woodward remembered that he still had on hand two sacks of meal from the Pierce Packing firm of Billings.

Samples of the meal were sent on Sept. 5 to the FDA laboratory in Seattle, but did not arrive until Sept. 11 because of a Hughes Air West strike. One of the samples finally tested on Sept. 12 was found to contain levels of PCB too high to measure — more than 1,000 parts per million, according to the FDA.

Three days later, the source of the PCBs was found to be the leaking transformer at Pierce Packing. Shortly afterward, the chairman of Pierce Packing made a statement alerting the public to the danger of PCB contamination in its meat and bone meal and began to recall the product, according to federal investigators.

So, the first public announcement of the problem was made more than five weeks after the Agriculture Department had located PCB-contaminated chickens at Ritewood Farms. By this time, the contaminated feed and chickens had moved widely across the country. Animal feed had been sent to six northwestern states.

The Campbell Soup Co. in Worthington, Minn., had already reported receiving PCB-contaminated chicken. Contaminated chickens had also been sent to Swift & Co., in Clinton, Iowa. More than 12,000 cases of Pepperidge Farms frozen strawberry cakes made with PCB-contaminated eggs, were reported in Utah. These products have either been destroyed or are awaiting destruction.

In early July, Ladle, the Provo mink raiser, had bought chicken viscera from Jolley Poultry to use in his mink feed. The chickens had come from Ritewood Farms. His mink started dying in late July.

Dr. J. Alan Thomas, head of the Utah State University animal diagnostic laboratory in Provo, says that the overwhelming majority of the dead mink he tested from Ladle's farm died from the effects of PCB. The rest died of natural causes.

FDA officials believe they have caught the current PCB contamination in time to avoid great harm to humans. They are grateful that Ritewood Farms was selling old hens, sold for products that take longer to make, like soup, rather than fryers which would

have been eaten by humans much sooner.

"It is our best judgment that the short-term nature of this incident and the levels of contamination found so far pose no immediate threat to the health of consumers in the United States," Acting FDA Commissioner Sherwin Gardner told a House Commerce subcommittee on Sept. 28.

The FDA says it believes that its investigators have traced most of the chickens and egg products that went into interstate commerce. The Agriculture Department says about 400,000 pounds of poultry, 16,000 pounds of fresh pork, and more than 50,000 pounds of egg products, such as frozen eggs, have been identified as contaminated and are being destroyed.

The government regards PCBs as such a toxic and persistent chemical that it has established rigid standards for disposal of them. High temperature incineration is recommended for material highly contaminated with PCBs, but the Environmental Protection Agency has yet to approve any PCB incinerator sites. Only eight chemical waste sites have been approved for PCB disposal.

PCB is the only chemical whose manufacture has

been banned by Congress. In 1976, Congress passed legislation forbidding manufacture or importation of PCBs, regulations that went into effect last June. However, these regulations do not ban use of those chemicals still on hand.

Therefore, the EPA has allowed the more than 700 million pounds that remain to be used in oils that serve as coolants and lubricants in electric transformers, capacitors and hydraulic systems, among other things. By one EPA estimate, there are more than 30 million transformers containing PCBs on utility poles in every part of the country.

"PCB contamination in the Western states is not the first such incident," the FDA's Gardner said. "Unfortunately, it will probably not be the last."

A000270

N 03188

NEVADA POWER COMPANY

10/22/79

MEMO TO: Distribution Listed

FROM: Donald Fabbi D.F.,

SUBJECT: PCB Control and Handling Procedures

Attached herewith are copy(s) of our PCB control and handling procedures for your use and or distribution to affected employees.

The policies and implementing procedures contained therein are mandatory for use by all affected personnel in order to achieve environmental requirements.

At this time most of the affected departments recordskeeping as specified in the procedures is presently being done by the Safety Department.

In the near future, you will receive additional revisions that will reflect recent changes in Company policy and regulatory requirements. Should you have any questions or need to request additional copies for personnel, let the Safety Department know.

Distribution List

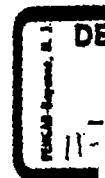
cc: A. E. Pearson
C. L. Ryan
J. McCarthy

R. Atkins - 5
R. Brown - 3
S. Burns - 2
R. Calle - 5
S. Claeys - 3
D. Crotta
J. Crum - 3
V. Daniels - 5
D. Dawson - 3
J. Diehl
J. Driscoll - 5
L. Dungy
R. Genseal
K. Grant - 2
F. Hall
R. Hall - 3
T. Harkenrider
W. Henson - 3
A. Hofmeister
W. James

A. Arebalo
W. Jones - 2
C. Kaiser - 2
E. Kulick - 5
R. Langford
T. Leavitt - 3
W. McGarry
R. McNeill
J. Middleron
W. Neville
D. Odell - 3
C. O'Neill
J. Freemon
R. Slate
C. Stewart
J. Strobel
H. Thompson - 2
C. Vaughn
J. Webb - 5
R. Whatley
S. Williams

Contractors
Commonwealth Elect.
Davey Tree Surgery

Agency
Public Service Commission



N. 0681

Southern Nevada's Only Home Owned Daily Newspaper

Las Vegas SUN

Late Sports

NEWS 365-3111

CIRCULATION 383-3078

VOL. 30 NO. 115 LAS VEGAS, NEVADA, THURSDAY, OCTOBER 25, 1979

20c 80 PAGES

Dangerous Leak Cleaned Up

A potentially cancer-causing chemical leaked down a Nevada Power Co. pole near Nellis Boulevard and Carey Wednesday after a minor explosion and fire ruptured a tank in a capacitor bank.

Jan Stroble, director of community information at Nevada Power, explained that a citizen reported the incident after 10:30 a.m. to the Clark County Fire Department.

Fire fighters alerted Nevada Power that a capacitor bank atop a pole in a 20-foot-wide easement of desert had ruptured and approximately one gallon of toxic PCB (poly chlorinated biphenyle) — believed to be a

cancer-causing substance — had leaked to the ground.

Stroble said a Nevada Power crew, accompanied by safety inspectors, dressed in protective clothing, cleaned up the PCB from the ground and pole and also "a few drops" which spilled on a nearby house.

The power pole is located on Nellis Boulevard, 100 feet east of Glendale.

Dr. John Santolucito of the federal Environmental Protection Agency (EPA) in Las Vegas, explained, exposure to PCB causes skin irritations and prolonged exposure can cause liver and nerve system damage.

A000272



N 03202

The Valley Times

"Stand with anybody that stands right. Stand with him while he is right, and part with him when he goes wrong." -- Abraham Lincoln

Phone: Circulation 642-1231 All other (702) 649-8700

North Las Vegas, Nevada 89030

15 Cents Per Copy

Thursday, October 25, 1979

Nevada Power Cleans Highly Toxic Spill

By ANN KOFOL
Times Staff Writer

More than two barrels of trash, soil and refuse which were contaminated with a highly toxic electrical insulating liquid as the result of a Nevada Power Co. equipment failure, were shoveled up and prepared for disposal Wednesday.

According to Don Fabbi, Nevada Power Co. safety director, a cleanup crew was dispatched to the area of Nellis Road and Glendale Ave. Wednesday morning following the failure of an electrical capacitor, atop a utility pole, resulting in a rupture of a container that housed two gallons of dielectric fluid. About a gallon of the insulating liquid leaked to the ground beneath the

pole, he said.

Comprising about 80 percent of the liquid, he said, is the substance PCB, polychlorinated biphenyl, a toxic chemical regulated by the Environmental Protection Agency and reputedly a cancer-causing agent.

Fabbi said, however, that the public was not endangered as cleanup crews scraped about one-half barrel of contaminated soil, and two barrels of refuse and weeds contained within a 5-foot radius of the utility pole.

"The substances we use are strictly liquid," Fabbi said, "so it doesn't create any gases or air contamination."

The contaminated refuse was scheduled for disposal at the Beatty toxic waste dump site, Fabbi said.

ANN00273



N 03201

Debate continues in PCB egg scare

BOISE, Idaho (UPI) — When a truck bumped an electrical transformer at a Montana meat-packing plant sometime last June, the driver probably didn't think much of it.

But the incident had far-reaching effects as 200 gallons of a cancer-causing chemical, PCB, leaked out of the transformer and into animal feed, eventually contaminating several hundred thousand pounds of eggs, chickens, pork, beef and processed foods in at least 17 states, from the West Coast to New Jersey.

Among the businesses most directly affected was the Ritewood Egg Co., the only major industry in tiny Franklin, Idaho, which was ordered by the federal government to destroy its entire inventory of hundreds of thousands of chickens and millions of eggs.

And one-third of Franklin's 400 residents underwent tests to determine whether the PCB level in their bodies was above federal standards. Fortunately, it wasn't.

The contamination did not come to public light until Sept. 11, more than two months after a sample of contaminated chicken from Ritewood was taken and three months after the original PCB spill.

PCB, or polychlorinated biphenyl, is used as a coolant for electrical equipment. It has been linked to skin disease, liver cancer, miscarriages and birth defects in tests on laboratory animals.

The Environmental Protection Agency outlawed the production of PCB in 1976, but the chemical still is found in millions of electrical transformers.

PCB accumulates in animal and human tissue, but scientists don't know how much PCB must be ingested to affect a person.

Idaho's chief health officer, Ed Gallagher of Boise, said a person would have to eat three or four dozen of the Ritewood eggs for 45 days before the PCB would have any effect.

"I think (the incident) was extremely overplayed," said Louis Mendoza, of Franklin, who said he continued to eat eggs from Ritewood Egg Co. even after they heard the eggs contained PCB.

"I just never felt overly alarmed about it," Mendoza said. "I don't think too many people around here did."

After the truck backed into the transformer at the Pierce Packing Co. in Billings, Mont., the PCB leaked into the plant's waste water system. Pierce dredges the waste water for byproducts for use in meat meal, an animal feed ingredient.

Farms all over the West and Midwest bought the PCB-tainted Pierce feed. Ritewood received its batch June 25.

A routine tissue sample from a Ritewood chicken was taken at a U.S. Department of Agriculture laboratory at Provo, Utah, on July 6. By the time the tests confirmed the PCB contamination and the USDA had notified the EPA and the U.S. Food and Drug Administration of the contaminated sample, it was Aug. 15.

The owners of the Ritewood farm were asked to halt sale of their chickens and eggs on Aug. 16 until the initial indication of PCB contamination could be confirmed.

By Sept. 3, further tests showed chicken tissue samples contained 20 to as many as 67 parts per million of PCB, far exceeding the federal limit of 3 parts per million.

Egg samples also showed excessive levels, so the FDA condemned all 550,000 chickens and millions of eggs at the farm.

It was estimated that 18 million PCB-tainted eggs already had been sold in Idaho and other western states.

The FDA linked the Ritewood feed with the Billings packing plant on Sept. 14. Then shipments of PCB-carrying meat were traced to a Campbell Soup Co. facility in Worthington, Minn.; Swift & Co. in Clinton, Iowa, and many

other food distribution outlets.

The Idaho Health and Welfare Department learned of the PCB incident Sept. 4. The public found out about it a week later through the press after Ritewood began burying its condemned chickens at the county landfill.

An FDA official in Seattle said the contamination was not announced immediately because the FDA "didn't want to cause a panic."

Blood and breast milk tests on about one-third of Franklin's 400 residents showed levels of PCB below the federal limit. They were tested because they used Ritewood products exclusively, and therefore they were more likely than anyone to have ingested the chemical.

Paul Woodward, part-owner of the Ritewood farm, blamed the federal agencies involved for "overreaction and slowness." He said the chickens and eggs which were destroyed could have been saved if the USDA had detected the PCB soon after the first tissue sample was taken.

And, noting that he and his partners were thinking of suing the government, Woodward also said the federal restrictions were too stringent.

CONTINUED ON NEXT PAGE

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DEBATE CONTINUES IN EGG SCARE (CONTINUED)

"I can't believe they thought this was so bad," Woodward said. "I don't see them getting all that excited about cancer-causing cigarettes."

The federal government's handling of the incident brought criticism of two kinds from Idaho politicians.

Gov. John V. Evans, a Democrat, blasted the USDA and FDA for not immediately notifying state officials about the Franklin contamination. He said it was "absolutely inexcusable."

Idaho Senate President Pro Tem Reed Budge, a Republican whose district includes Franklin and who said he was sure he had eaten several dozen of the contaminated Ritewood eggs, said the United States is becoming "too sophisticated."

"We might be nearing a sterile society. We're just getting regulations to the point where it's becoming counterproductive to society. This whole PCB thing has been far overplayed."

Carol Foreman, assist-

ant secretary of agriculture, had another view.

"In light of this incident, it is clear that the department must give special attention to environmental contaminants in the food supply," she said, adding that the detection of PCB at the Idaho farm was a chance occurrence.

"We should have far more sensitivity to the potential gravity of this type of situation," she said.

David Fors, manager of Fors Farms, Pullayup, Wash., called himself "an innocent victim." He said the destruction of his chickens amounted to a loss of around \$500,000.

The owners of the Ritewood farm estimated their loss was more than \$1 million.

Other food producers and retailers fared little better, some losing money

even though their products were not found to be contaminated by PCB.

Neal Ambrose, owner of Ambrose Farms of Wendell, Idaho, said he had "hundreds" of hogs no one would buy because tests for PCB poisoning at his farm were publicized.

A000275

N 03186



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

215 Fremont Street
San Francisco, Ca. 94105

EXECUTIVE OFF

CERTIFIED MAIL NO. 552453
RETURN RECEIPT REQUESTED

In Reply E-3-3
Refer to: - TSCA-IX-002C

Mr. Arthur E. Pearson
Nevada Power Company
P.O. Box 230
Las Vegas NV 89151

NOV 24 1979

Subject: In re Nevada Power Company
Complaint and Notice of Opportunity for Hearing
Docket No. TSCA-IX-002C

Dear Mr. Pearson:

Enclosed please find a Complaint and Notice of Opportunity for Hearing concerning violations of the Toxic Substances Control Act (TSCA), 15 USC 2601 et seq.

The Complaint and the Rules of Practice, 40 CFR Part 22, set forth the alternatives available to you in responding to the alleged facts, violations, proposed penalty, and opportunity for a hearing. It should be emphasized that if you wish to request a hearing and avoid being found in default, you must file a written Answer within fifteen (15) days of your receipt of the Complaint.

Whether or not you choose to request a hearing, you are encouraged to explore the possibility of settlement by contacting Keith Takata, U.S. Environmental Protection Agency, Region IX, Enforcement Division, 215 Fremont Street, San Francisco, California 94105, telephone (415)556-8008.

Sincerely,

Clyde B. Eller
Clyde B. Eller
Director
Enforcement Division

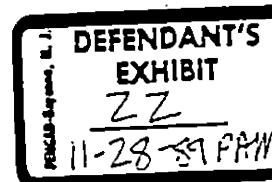
Enclosures

cc: EPA Environmental Monitoring and Support Laboratory
Clark County Health District



N 07065

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[6560-01]

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL
PROTECTION AGENCY

(FRL 919-8)

PART 22—CONSOLIDATED RULES OF
PRACTICE GOVERNING THE AD-
MINISTRATIVE ASSESSMENT OF
CIVIL PENALTIES OR THE REVOCATION
OR SUSPENSION OF PERMITS

Interim Rules of Practice

AGENCY: Environmental Protection
Agency (EPA).

ACTION: Interim rules of practice.

SUMMARY: These rules of practice set forth procedures to be followed by parties litigating administratively assessed civil penalties under section 15(a) of the Toxic Substances Control Act (TSCA). The rules are being promulgated in interim form so that they may be in place to guide civil penalty actions presently arising under TSCA.

DATE: Effective date: August 1, 1978.

Comments on the rules should be received on or before October 3, 1978.

ADDRESS: Comments should be directed to:

Steve Laffer, Attorney, Toxic Substances Branch (EPA-312), Pesticides and Toxic Substances Enforcement Division, EPA, 401 M Street SW., Washington, D.C. 20460, 202-755-9404.

FOR FURTHER INFORMATION
CONTACT:

Steve Laffer, 202-755-9404.

SUPPLEMENTARY INFORMATION: These consolidated rules of practice govern adjudicatory proceedings for the assessment of civil penalties under section 15(a) of the Toxic Substances Control Act (15 U.S.C. 2601 et seq.). These rules were developed as part of a larger project covering five statutes administered by EPA. The result of this project is the Consolidated Rules, which are set forth below in interim form. The rules are proposed with respect to the other four statutes, and can be found in the proposed rules portion of this part. The proposed and interim rules will be promulgated under a single heading in final form.

For an expanded discussion of the rules, see the preamble to the proposed rules.

NOTE—EPA has determined that this document does not contain a major Federal action requiring preparation of an Economic Impact Analysis Statement under Executive Order No. 12044.

RULES AND REGULATIONS

Accordingly, the new Part 22 set forth below is hereby added to 40 CFR under the authority of TSCA section 16(a), and is effective on an interim basis on August 4, 1978.

Dated: July 26, 1978.

DOUGLAS M. COSTLE,

Administrator.

RULES OF PRACTICE GOVERNING THE ADMINISTRATIVE ASSESSMENT OF CIVIL PENALTIES UNDER THE TOXIC SUBSTANCES CONTROL ACT

Subpart A—General

- Sec.
- 22.01 Scope of these rules.
 - 22.02 Use of number and gender.
 - 22.03 Definitions.
 - 22.04 Powers and duties of the Administrator, Regional Administrator, judicial officer, national judicial officer, and presiding officer; disqualification.
 - 22.05 Filing, service, and form of pleadings and documents.
 - 22.06 Filing and service of rulings, orders and decisions.
 - 22.07 Computation and extension of time.
 - 22.08 Ex parte discussion of proceedings.
 - 22.09 Examination of documents filed.

Subpart B—Parties and Appearances

- 22.10 Appearances.
- 22.11 Intervention.
- 22.12 Consolidation and severance.

Subpart C—Preliminary Procedures

- 22.13 Issuance of complaint.
- 22.14 Content and amendment of the complaint.
- 22.15 Answer to the complaint.
- 22.16 Motions.
- 22.17 Default order.
- 22.18 Informal settlement; consent agreement and order.
- 22.19 Prehearing conference.
- 22.20 Accelerated decision; summary.

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- 22.21 Scheduling the hearing.
- 22.22 Evidence.
- 22.23 Objections and offers of proof.
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- 22.25 Filing the transcript.
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Subpart E—Initial Decision and Motion To
Rescind a Hearing

- 22.27 Initial decision.
- 22.28 Motion to rescind a hearing.

Subpart F—Appeals and Administrative
Review

- 22.29 Appeal from or review of interlocutory orders or rulings.
- 22.30 Appeal from or review of initial decision.

Subpart G—Final Order on Appeal

- 22.31 Final order on appeal.
- 22.32 Motion to reconsider a final order.

Subpart H—Supplemental Rules of
Governing Administrative Assess-
ment of Civil Penalties Under the Toxic Sub-
stances Control Act

22.33 Supplemental rules of prac-
tice governing administrative assess-
ment of civil penalties under the Toxic Sub-
stances Control Act.
Appendix.

Authority: Sec. 16(a) of the To-
xic Substances Control Act (15 U.S.C. 2601).

Subpart A—General

§ 22.01 Scope of these rules.

(a) Unless otherwise specified, rules of practice govern all ad-
judicatory proceedings for the assess-
ment of any civil penalty conducted un-
der section 16(a) of the Toxic Sub-
stances Control Act (15 U.S.C. 2601(a)).
Supplemental procedures set forth
rules governing those aspects of
proceedings in question which are
covered in these rules, and also
procedures which supplement or
modify procedures set forth in
this part.

(b) Questions arising at any stage
of the proceeding which are not
addressed in these rules shall be re-
solved at the discretion of the presiding
officer or the Administrator, as ap-
propriate.

§ 22.02 Use of number and gender.

As used in these rules of prac-
tice, words in the singular also include
plural and words in the ma-
jor gender also include the femi-
ne vice versa, as the case may require.

§ 22.03 Definitions.

(a) The term "Act" means the
Toxic Substances Control Act (15
U.S.C. 2601 et seq.).

(b) "Administrative law
judge" means an administrative law
judge appointed under 5 U.S.C. 3105 (or
Pub. L. 95-581, 92 Stat. 1001). This
is synonymous with the term "ad-
judicator" as used in the Act.
(c) "Administrator" means the
Administrator of the U.S. Environ-
mental Protection Agency or his designee.

(d) "Agency" means the U.S.
Environmental Protection Agency.

(e) "Complainant" means any
person authorized to issue a complaint
on behalf of the Agency to pers-
on alleged to be in violation of the Act.
Complainant shall not be the re-
spondent, or any other person who
will participate or advise in the
decision.

(f) "Consolidation" means a
communication, including one or
more violations of administrative pro-
cedures or regulations promulgated
under the Act, issued by the commission-
ing person under §§ 22.15 and 22.16.

(g) "Consent agreement" means a written document, signed by the parties, containing stipulations or conclusions of fact or law and a proposed penalty acceptable to both complainant and respondent.

(h) "Final order" means an order issued by the Administrator disposing of a matter in controversy between the parties or an initial decision which becomes a final order under § 22.27(c).

(i) "Hearing" means a hearing on the record open to the public and conducted under these rules of practice.

(k) "Hearing Clerk" means the Hearing Clerk, U.S. Environmental Protection Agency, Washington, D.C. 20460.

(l) "Initial decision" means the decision issued by the presiding officer based upon the record of the proceedings out of which it arises.

(m) "Judicial officer" means the person designated by the Administrator under § 22.04(b) to serve as the judicial officer.

(n) "Party" means any person that participates in a hearing as complainant, respondent, or intervenor.

(o) "Person" includes any individual, partnership, association, corporation, and any trustee, assignee, receiver, or legal successor thereof; any organized group of persons whether incorporated or not; and any officer, employee, agent, department, agency, or instrumentality of the Federal Government, of any State or local unit of government, or of any foreign government.

(p) "Presiding officer" means the administrative law judge designated by the Chief Administrative Law Judge to serve as presiding officer, unless otherwise specified by any supplemental rules.

(q) "Regional Administrator" means the Administrator of any regional office of the Agency or any officer or employee thereof to whom his authority is duly delegated. Where the Regional Administrator has authorized the regional judicial officer to act, the term "Regional Administrator" shall include the regional judicial officer.

(r) "Regional Hearing Clerk" means an individual duly authorized by the regional Administrator to serve as hearing clerk for a given region. Correspondence may be addressed to the regional Hearing Clerk, U.S. Environmental Protection Agency (address of regional office—see appendix).

(s) "Regional Judicial Officer" means a person designated by the regional administrator under § 22.04(b) to serve as a regional judicial officer.

(t) "Respondent" means any person proceeded against in the complaint.

(u) Terms defined in the act and not defined in these rules of practice are given consistent with the meanings given in the act.

§ 22.04 Powers and duties of the Administrator, regional administrator, judicial officer, regional judicial officer, and presiding officer; disqualification.

(a) Administrator and regional administrator. The administrator and the regional administrator shall exercise all powers and duties as prescribed or delegated under the Act and these rules of practice.

(b) Judicial officer and regional judicial officer. (1) Office. One or more judicial officers may be designated by the administrator to perform the functions described below. One or more regional judicial officers may be designated by the regional administrator to perform, within the region of their designation, the functions described below.

(2) Qualifications. A judicial officer or a regional judicial officer shall be an attorney who is a permanent or temporary employee of the Agency or some other Federal agency and who may perform other duties within the Agency. A regional judicial officer shall not be employed by the region's enforcement division or by the regional division directly associated with the type of violation at issue in the proceeding. The regional judicial officer shall not have performed prosecutorial or investigative functions in connection with any hearing in which he participates as regional judicial officer or any related hearing. A judicial officer shall not be a member of the office of enforcement.

(3) Functions. The administrator may delegate to the judicial officer, or the regional administrator may delegate to the regional judicial officer, all or part of his authority to act in a given proceeding. This delegation does not prevent the judicial officer or regional judicial officer from referring any motion or case to the Administrator or regional administrator when appropriate. The judicial officer and regional judicial officer shall exercise all powers and duties prescribed or delegated under the act or these rules of practice.

(c) Presiding officer. The presiding officer shall conduct a fair and impartial proceeding, assure that the facts are fully elicited, adjudicate all issues, and avoid delay. The presiding officer shall have authority to:

(1) Conduct administrative hearings under these rules of practice;

(2) Rule upon motions, requests, and offers of proof, dispose of procedural requests, and issue all necessary orders;

(3) Administer oaths and affirmations and take affidavits;

(4) Examine witnesses, receive documentary or other evidence;

(5) For good cause, upon motion or sua sponte, order a party, or an officer or agent thereof, to produce testimony, documents or other nonprivileged

information, and failing the production thereof without good cause being shown, draw adverse inferences against that party;

(6) Admit or exclude evidence;

(7) Hear oral argument on facts or law;

(8) Require parties to attend conferences for the settlement or simplification of the issues, or the expedition of the proceedings;

(9) Issue subpoenas authorized by the act and

(10) Do all other acts and take all measures necessary for the maintenance or order and for the efficient, fair, and impartial adjudication of issues arising in proceedings governed by these rules.

(d) Disqualification; withdrawal. (1) The administrator, regional administrator, judicial officer, regional judicial officer, or presiding officer may not perform functions provided for in these rules of practice regarding any matter in which they (i) have a financial interest or (ii) have any relationship with a party or with the subject matter which would make it inappropriate for them to act. Any party may at any time by motion made to the regional administrator request that the regional judicial officer or presiding officer be disqualified from the proceeding. Any party may at any time by motion to the administrator request that the regional administrator or judicial officer be disqualified or request that the administrator disqualify himself from the proceeding. The administrator, regional administrator, judicial officer, regional judicial officer, or presiding officer may at any time withdraw from any proceeding in which they deem themselves disqualified or unable to act for any reason.

(2) If the regional administrator, regional judicial officer, judicial officer, or presiding officer is disqualified or withdraws from the proceeding, a qualified individual who has none of the infirmities listed in paragraph (d)(1) of this section shall be assigned to replace him. Assignment of a replacement for the regional administrator or judicial officer, or for the regional judicial officer shall be made by the administrator or the regional administrator, respectively. The administrator shall assign the regional administrator from the region where the case originated to replace the administrator should he withdraw or disqualify himself. The regional administrator shall assign a new presiding officer if the original presiding officer was not an administrative law judge. The chief administrative law judge shall assign a new presiding officer from among available administrative law judges if the original presiding officer was an administrative law judge.

(3) The chief administrative judge, at any stage in the proceeding, may reassign the case to an administrative law judge other than the one originally assigned in the event of the unavailability of the administrative law judge or where reassignment will result in efficiency in the scheduling of hearings.

§ 22.05 Filing, service, and form of pleadings and documents.

(a) *Filing of pleadings and documents.* (1) The original and two copies of the complaint, of the answer, and of all subsequent documents served in the proceeding shall be filed with the regional hearing clerk. The regional hearing clerk shall open and maintain the official file of the proceeding upon receipt of the complaint. The regional hearing clerk shall forward a copy of the complaint to the presiding officer upon his assignment to the proceeding.

(2) A certificate of service shall accompany each document filed or served. Except as otherwise provided, a party filing documents with the regional hearing clerk, after the filing of the complaint, shall serve copies thereof upon all other parties and the presiding officer at the same time.

(3) Notwithstanding § 22.05(a)(1), when the presiding officer corresponds directly with the parties, the original or the correspondence shall be sent to the regional hearing clerk, a copy shall be maintained by the presiding officer in the duplicate file, and a copy shall be sent to all parties. Parties who correspond directly with the presiding officer shall in addition to serving all other parties send a copy of all such correspondence to the regional hearing clerk. A certificate of service shall accompany each document served under this subsection.

(b) *Service of pleadings and documents.* (1) *Service of complaint.* (i) Service of the complaint, together with a copy of these rules of practice, may be made personally or by certified mail, return receipt requested, on the respondent (or his representative).

(ii) Service upon a domestic or foreign corporation or upon a partnership or other unincorporated association which is subject to suit under a common name shall be made by personal service or certified mail, as prescribed by subparagraph (1)(i) of this paragraph, directed to an officer, partner, a managing or general agent, or to any other person authorized by appointment or by Federal or State law to receive service of process.

(iii) Service upon an officer or agency of the United States shall be made by delivering a copy of the complaint to the officer or agency, or in any manner prescribed for service by applicable regulations. If the agency is

a corporation, the complaint shall be served as prescribed in subparagraph (1)(ii) of this paragraph.

(iv) Service upon a State or local unit of Government, or a State or local officer, agency, department, corporation, or other instrumentality shall be made by serving the complaint in the manner prescribed by the law of the State for the service of process on any such person, or:

(A) If upon a State or local unit of Government, or a State or local department, agency, corporation, or other instrumentality, by delivering a copy of the complaint to the chief executive officer thereof;

(B) If upon a State or local officer by delivering a copy to such officer.

(v) Proof of service of the complaint shall be made by affidavit of the person making personal service, or by properly executed return receipt. Such proof of service shall be filed with the complaint immediately upon completion of service.

(2) *Service of documents other than complaint.* All documents other than the complaint may be served personally or by certified or first class mail. A certificate of service shall accompany each document served.

(c) *Form of pleadings and documents.* (1) Except as provided herein, or by order of the presiding officer or administrator, there are no specific requirements as to the form of documents.

(2) The first page of every pleading, letter, or other document shall contain a caption identifying the respondent and the docket number which is exhibited on the complaint.

(3) The original of any pleading, letter or other document (other than exhibits) shall be signed by the party filing or by his counsel or other representative. The signature constitutes a representation by the signer that he has read the pleading, letter or other document, that to the best of his knowledge, information, and belief, the statements made therein are true, and that it is not interposed for delay.

(4) The original document filed by any person shall contain his name, address, and telephone number. Any changes in this information shall be communicated promptly to the regional hearing clerk, presiding officer, and all parties to the proceeding. A party who fails to furnish such information shall be deemed to have waived his right to notice and service under these rules.

(5) The administrator, presiding officer, hearing clerk, or regional hearing clerk may refuse to file any document which does not comply with this paragraph. Written notice of such refusal shall be promptly given to the person submitting the document.

§ 22.06 Filing and service of rulings, orders, and decisions.

All rulings, orders, decisions, and other documents issued by the regional administrator, regional judicial officer, or the presiding officer, as appropriate, shall be filed with the regional hearing clerk. All such documents issued by the administrator or judicial officer shall be filed with the hearing clerk. Copies of such rulings, orders, decisions, or other documents shall be served directly upon all parties by the administrator, regional administrator, judicial officer, regional judicial officer, or presiding officer, as appropriate.

§ 22.07 Computation and extension of time.

(a) *Computation.* In computing any period of time prescribed or allowed in these rules of practice, except as otherwise provided, the day of the event from which the designated period begins to run shall not be included. Saturdays, Sundays, and Federal legal holidays shall be included in computing the time allowed for such filing. However, if the period of time prescribed is five (5) days or less, intermediate Saturdays, Sundays, and legal holidays shall be excluded from the computation. When a stated time expires on a Saturday, Sunday or legal holiday, the stated time period shall be extended to include the next business day.

(b) *Extensions of time.* The presiding officer may grant an extension of time for the filing of any pleading, document, or motion (1) upon timely motion of a party to the proceeding only for good cause shown and after consideration of prejudice to other parties, or (2) upon his own motion. Such a motion by a party may only be made after notice to all other parties, unless the movant can show good cause why serving notice is impracticable. The motion shall be filed in advance of the date on which the pleading, document or motion is due to be filed, unless the failure of a party to make timely motion for extension of time was the result of excusable neglect.

(c) *Service by mail.* Service is complete upon mailing. However, where a pleading or document is served by mail, five (5) days shall be added to the time allowed by these rules for the filing of a responsive pleading.

§ 22.08 Ex parte discussion of proceedings

At no time after the issuance of the complaint shall the administrator, regional administrator, judicial officer, regional judicial officer, presiding officer, or any other person who will advise these officials in the decision of the case, discuss ex parte the merits of the proceeding with any interested

son outside the Agency, with any Agency staff member who performs a secretarial or investigative function in such proceeding or a related proceeding, or with any representative of a person. Any memorandum or other communication addressed to the Administrator, regional administrator, chief officer, regional judicial officer or the presiding officer during the pendency of the proceeding and relating to the merits thereof, by or on behalf of any party shall be regarded as argument made in the proceeding and shall be served upon all other parties. The other parties shall be given opportunity to reply to such memorandum or communication.

§ 22.10 Examination of documents filed.

Subject to the provisions of law relating to the public disclosure of confidential information, any person during Agency business hours, may inspect and copy any document filed in any proceeding. Such documents shall be made available by the regional hearing clerk or hearing clerk, as appropriate.

The cost of duplicating documents filed in any proceeding shall be borne by the person seeking copies of documents.

Part D—Parties and Appearances

1. Appearances.

A party may appear in person or by counsel or other representative. A person may appear on behalf of a partnership and an officer may appear on behalf of a corporation. Persons appearing as counsel or other representative must conform to the standards of conduct and ethics required of attorneys before the courts of the United States.

Intervention.

Motion. Any person may file a motion for leave to intervene in any proceeding conducted under these rules of practice. The motion must set forth the grounds for the proposed intervention, the position and interest of the movant and the likely impact that intervention will have on the expeditious progress of the proceeding. Any person already a party to a proceeding may file an answer to a motion to intervene, making specific reference to the grounds set forth in the foregoing motion and paragraph (c) of this section within ten (10) days after service of the motion for leave to intervene. If not filed, a motion for leave to intervene in a proceeding must ordinarily be filed before the first prehearing conference or, in the absence of a prehearing conference, before the initial conference under paragraph (e), or if there is no such conference, prior to the setting of a

date and place for a hearing. Any motion filed after that time must include, in addition to the information set forth in paragraph (a) of this section, a statement of good cause for the failure to file in a timely manner. An untimely motion for leave to intervene shall be granted only upon finding that extraordinary circumstances justify the granting of the motion. The intervenor shall be bound by any agreements, arrangements and other matters previously made in the proceeding.

(c) **Disposition.** Leave to intervene shall be granted only if the movant demonstrates that (1) there exists a common question of law or fact, and (2) his presence in the proceeding would not unduly prolong or otherwise prejudice the adjudication of the rights of the original parties. In evaluating the merits of a motion for leave to intervene, the presiding officer shall consider the extent to which the movant will be adversely affected by a final order and the extent to which the interests of the movant are not being adequately represented by the original parties.

(d) **Amicus curiae.** Persons not parties to the proceeding who wish to file briefs may, upon good cause shown, so move the presiding officer or the Administrator as appropriate. The motion shall identify the interest of the applicant and shall state the reasons why the proposed amicus brief is desirable. If the motion is granted, the presiding officer or Administrator shall issue an order setting the time for filing such brief. An amicus curiae is eligible to participate in any briefing after his motion is granted, and shall be served with all briefs, reply briefs, motions, and orders relating to issues to be briefed.

§ 22.12 Consolidation and severance.

(a) **Consolidation.** The presiding officer may, by motion or sua sponte, consolidate any or all matters at issue in two or more proceedings conducted under these rules of practice where there exist common parties of common questions of fact or law, and where consolidation would expedite or simplify consideration of the issues. Consolidation shall not affect the right of any party to raise issues that could have been raised if consolidation had not occurred.

(b) **Severance.** The presiding officer may, by motion or sua sponte, for good cause shown, order any proceedings severed with respect to any or all parties or issues.

Subpart C—Prehearing Procedures

§ 22.13 Issuance of complaint.

If the complainant has reason to believe that a person has violated any provision of the act or regulations pro-

mulgated under the act, he may institute a proceeding for the assessment of a civil penalty by issuing a complaint under the act and these rules of practice.

§ 22.14 Content and amendment of the complaint.

(a) **Content of complaint.** Each complaint shall include:

(1) A statement reciting the section(s) of the act authorizing the issuance of the complaint;

(2) Specific reference to each provision of the act and implementing regulations which respondent is alleged to have violated;

(3) A concise statement of the factual basis for alleging the violation;

(4) The amount of the civil penalty which is proposed to be assessed;

(5) A statement indicating the appropriateness of the proposed penalty;

(6) Notice of respondent's right to request a hearing on any material fact contained in the complaint, or on the appropriateness of the amount of the proposed penalty.

A copy of these rules of practice shall accompany each complaint served.

(b) **Determination of proposed civil penalty.** The dollar amount of the proposed civil penalty shall be determined in accordance with any criteria set forth in the act relating to the proper amount of a civil penalty and with any civil penalty guidelines published under the act.

(c) **Amendment of the complaint.** The complainant may amend the complaint as a matter of right at any time before the answer is filed. Respondent shall have fifteen (15) additional days from the date of service of the amended complaint to file his answer. At any time after the filing of an answer to the complaint, the complaint may be amended only upon motion granted by the presiding officer.

(d) **Withdrawal of the complaint.** The complainant may withdraw the complaint without prejudice one time before the answer has been filed. The complainant may withdraw the complaint, without prejudice, only upon motion granted by the presiding officer.

§ 22.15 Answer to the complaint.

(a) **General.** Where respondent (1) contests any material fact upon which the complaint is based; (2) contends that the amount of the penalty proposed in the complaint is inappropriate; or (3) contends that he is entitled to judgment as a matter of law, he shall file a written answer to the complaint with the regional hearing clerk. Any such answer to the complaint must be filed with the regional hearing clerk within fifteen (15) days after service of the complaint.

(b) *Contents of the answer.* The answer shall clearly and directly admit, deny or explain each of the factual allegations contained in the complaint with regard to which respondent has any knowledge. Where respondent has no knowledge of a particular factual allegation and so states, the allegation is deemed denied. The answer shall also state (1) the circumstances or arguments which are alleged to constitute the grounds of defense, (2) the facts which respondent intends to place at issue, and (3) whether a hearing is requested.

(c) *Request for hearing.* A hearing upon the issues raised by the complaint and answer shall be held upon request of respondent in the answer. In addition, a hearing may be held at the discretion of the presiding officer, sua sponte, if issues appropriate for adjudication are raised in the answer, although no hearing is requested, or upon motion of any party other than the respondent. Any request for hearing filed by a party other than the respondent shall state objections to the complaint with particularity and shall set forth the issues which the party intends to raise during the hearing.

(d) *Failure to admit, deny, or explain.* Failure of respondent to admit, deny, or explain any material factual allegation contained in the complaint constitutes an admission of the allegation.

(e) *Amendment of the answer.* The respondent may amend the answer to the complaint upon motion granted by the presiding officer.

§ 22.16 Motions.

(a) *General.* All motions, except those made orally on the record during a hearing, shall (1) be in writing; (2) state the grounds therefor with particularity; (3) set forth the relief or order sought; and (4) be accompanied by any affidavit, certificate, other evidence, or legal memorandum relied upon. Such motions shall be served as provided by § 22.05(b)(2).

(b) *Response to motions.* Any party may file a response to any written motion within ten (10) days after service of such motion, except as otherwise provided by the presiding officer or the Administrator. This response shall be accompanied by any affidavit, certificate, legal memorandum, or other evidence relied upon. If no response is filed within the designated period, the parties may be deemed to have waived any objection to the granting of the motion. The presiding officer or Administrator may set a shorter time for response, or make such other orders concerning the disposition of motions as they deem appropriate.

(c) *Decision.* The Administrator shall rule upon all motions filed or made after the filing of an initial decision, except as provided in § 22.17. The presiding officer shall rule on all other motions. Oral argument on motions will be permitted where the presiding officer or the Administrator considers it necessary or desirable.

§ 22.17 Default order.

(a) *Default.* A party may be found to be in default (1) after motion, upon failure to file a timely answer to the complaint; (2) after motion or sua sponte, upon failure to comply with a prehearing or hearing order of the presiding officer; or (3) after motion or sua sponte, upon failure to appear at a conference or hearing without good cause being shown. No finding of default on the basis of a failure to appear at a hearing shall be made unless the appearing party presents sufficient evidence to the presiding officer to establish a prima facie case against the opposing party. Any motion for a default order shall include a proposed default order and shall be served upon all parties. The alleged defaulting party shall have fifteen (15) days from service to reply to the motion. Default by respondent constitutes an admission of all facts alleged in the complaint and a waiver of respondent's right to a hearing on such factual allegations. The civil penalty proposed in the complaint shall become due and payable by respondent without further proceedings sixty (60) days after a final order issued upon default. Default by the complainant shall result in the dismissal of the complaint with prejudice.

(b) *Procedures upon default.* When the presiding officer finds a default has occurred, he shall render a proposed default order to be issued against the defaulting party. This order constitutes the initial decision of the presiding officer, and shall be filed with the regional hearing clerk.

(c) *Contents of a proposed default order.* A proposed default order shall include findings of fact, conclusions regarding all material issues of law, fact, or discretion, and the penalty which is therein assessed.

§ 22.18 Informal settlement; consent agreement and order.

(a) *Settlement policy.* The Agency encourages settlement of a proceeding at any time if the settlement is consistent with the provisions and objectives of the Act and applicable regulations. The respondent may confer with complainant concerning the settlement whether or not respondent requests a hearing. Settlement conferences shall not affect the respondent's obligation to file a timely answer under § 22.16.

(b) *Consent agreement.* The parties shall forward a signed written consent agreement and a proposed consent order to the Regional Administrator whenever settlement or compromise is proposed. The consent agreement shall state that, for the purpose of this proceeding, respondent (1) admits the jurisdictional allegations of the complaint; (2) admits the facts stipulated in the consent agreement or neither admits nor denies specific factual allegations contained in the complaint; and (3) consents to the assessment of a stated civil penalty. The consent agreement shall include any and all terms of the agreement.

(c) *Consent order.* No settlement or consent agreement shall dispose of any proceeding under these rules of practice without a consent order from the Regional Administrator. In preparing such an order, the Regional Administrator may require that the parties to the settlement appear before him to answer inquiries relating to the consent agreement or order.

§ 22.19 Prehearing conference.

(a) *Purpose of prehearing conference.* Unless a conference appears unnecessary, the presiding officer, at any time before the hearing begins, shall direct the parties and their counsel or other representative to appear at a conference before him to consider:

- (1) The settlement of the case;
- (2) The simplification of issues and stipulation of facts not in dispute;
- (3) The necessity or desirability of amendments to pleadings;
- (4) The exchange of exhibits, documents, prepared testimony, and admissions or stipulations of fact which will avoid unnecessary proof;
- (5) The limitation of the number of expert or other witnesses;
- (6) Setting a time and place for the public hearing; and
- (7) Any other matters which may expedite the disposition of the proceeding.

(b) *Exchange of witness lists and documents.* Unless otherwise ordered by the presiding officer, each party at the prehearing conference shall make available to all other parties the names of the expert and other witnesses he intends to call, together with a brief narrative summary of their expected testimony. Copies of all documents and exhibits which each party intends to introduce into evidence shall be marked for identification as ordered by the presiding officer.

(c) *Record of the prehearing conference.* No transcript of any prehearing conference shall be made unless ordered by the presiding officer upon motion of a party or sua sponte. The presiding officer shall prepare and file for the record a written summary of the action taken at the conference.

The summary shall incorporate any written stipulations or agreements of the parties and all rulings and appropriate orders containing directions to the parties.

(d) *Location of prehearing conference.* The prehearing conference shall be held in the city in which the relevant Environmental Protection Agency Regional Office is located unless (1) the presiding officer determines that there is good cause to hold it at another location in the region or by telephone, or (2) supplemental rules of practice published under the Act provide otherwise.

(e) *Unavailability of a prehearing conference.* If a prehearing conference is unnecessary or impracticable, the presiding officer, on motion or sua sponte, may direct the parties to correspond with him to accomplish any of the objectives set forth in this section.

§ 22.20 Accelerated decision: dismissal.

(a) *General.* The presiding officer, upon motion of any party or sua sponte, may at any time render an accelerated decision in favor of the complainant or the respondent as to all or any part of the proceeding, without further hearing or upon such limited additional evidence, such as affidavits, as he may require, or dismiss any party with prejudice, under any of the following conditions:

(1) Failure to state a claim upon which relief can be granted, or direct or collateral estoppel;

(2) No genuine issue of material fact exists and a party is entitled to judgment as a matter of law, as to all or any part of a proceeding; or

(3) Such other reasons as are just.

(b) *Effect.* (1) If an accelerated decision is issued as to all the issues and claims in the proceeding, the decision constitutes an initial decision of the presiding officer, and shall be filed with the regional hearing clerk.

(2) If an accelerated decision is rendered on less than all issues or claims in the proceeding, the presiding officer shall determine what material facts exist without substantial controversy and what material facts remain controverted in good faith. He shall thereupon issue an interlocutory order specifying the facts which appear substantially uncontroverted, and the issues and claims upon which the hearing will proceed.

Support D—Hearing Procedure

§ 22.21 Scheduling the hearing.

(a) When a complaint is filed, the regional hearing clerk or hearing clerk shall refer the proceeding to the Chief Administrative Law Judge who shall assign himself or another administrative law judge as presiding officer. The presiding officer shall then notify the parties of his assignment.

(b) *Notice of hearing.* If the respondent requests a hearing in his answer, or one is ordered by the presiding officer under § 22.15(c), the presiding officer shall serve upon the parties a notice of hearing. This notice shall set a time and place for the hearing and may provide for a future prehearing conference. The presiding officer may issue the notice of hearing after a prehearing conference is held. The parties shall be notified at least fifteen (15) days prior to the date set for the hearing.

(c) *Postponement of hearing.* No request for postponement of a hearing will be granted except upon motion and for good cause shown.

(d) *Location of the hearing.* The location of the hearing shall be determined in accordance with the method for determining the location of a prehearing conference under § 22.19(d).

§ 22.22 Evidence.

(a) *General.* The presiding officer shall admit all evidence which is not irrelevant, immaterial, unduly repetitious, or otherwise unreliable or of little probative value, except that statements made during settlement conferences are not admissible. In the presentation, admission, disposition, and use of evidence, the presiding officer shall preserve the confidentiality of trade secrets and other privileged commercial and financial information. The confidential or trade secret status of any information shall not, however, preclude its being introduced into evidence. The presiding officer may make such orders as may be necessary to consider such evidence in camera, including the preparation of a supplemental initial decision to address questions of fact, law, or discretion which arise out of that portion of the evidence which is confidential or which includes trade secrets.

(b) *Examination of witnesses.* Witnesses shall be examined orally, under oath or affirmation, except as otherwise provided in these rules of practice or by the presiding officer. Parties shall have the right to cross-examine a witness who appears at the hearing provided that such cross-examination is not unduly repetitious.

(c) *Verified statements.* The presiding officer may admit and insert into the record as evidence, in lieu of oral testimony, statements of fact or opinion prepared by a witness. The admissibility of the evidence contained in the statement shall be subject to the same rules as if the testimony were produced under oral examination. Before any such statement is read or admitted into evidence, the witness shall deliver a copy of the statement to the presiding officer, the reporter, and opposing counsel. The witness presenting the statement shall swear to

or affirm the statement and shall be subject to appropriate oral cross-examination upon the contents thereof.

(d) *Admission of affidavits where the witness is unavailable.* The presiding officer may, upon good cause shown, admit into evidence affidavits of witnesses who are unable to be present at the hearing.

(e) *Exhibits.* Where practicable, an original and one copy of each exhibit shall be filed with the presiding officer for the record and a copy shall be furnished to each party. A true copy of any exhibit may be substituted for the original.

(f) *Official notice.* Official notice may be taken of any matter judicially noticed in the Federal courts, and of other facts within the specialized knowledge and experience of the Agency. Opposing parties shall be given adequate opportunity to show that such facts are erroneously noticed.

§ 22.23 Objections and offers of proof.

(a) *Objection.* Any objection concerning the conduct of the hearing may be stated orally or in writing during the hearing. The party raising the objection must supply a short statement of its grounds. The ruling by the presiding officer on any objection and the reasons given for it shall be part of the record. An exception to each objection overruled shall be automatic and is not waived by further participation in the hearing.

(b) *Offer of proof.* Whenever evidence is excluded from the record, the party offering the evidence may make an offer of proof, which shall be included in the record. The offer of proof for excluded oral testimony shall consist of a brief statement describing the nature of the evidence excluded. The offer of proof for excluded documents or exhibits shall consist of the insertion in the record of the documents or exhibits excluded. Where the Administrator decides that the ruling of the presiding officer in excluding the evidence was both erroneous and prejudicial, the hearing may be reopened to permit the taking of such evidence or, where appropriate, the Administrator may evaluate such evidence in preparing his final order. If the Administrator in the preparation of his final order relies upon any evidence excluded at the hearing by the presiding officer, he shall explicitly identify in the final order any such excluded evidence relied upon and his reasons therefor.

§ 22.24 Burden of presentation: burden of persuasion.

The complainant has the burden of going forward with and of proving that the violation occurred as set forth in the complaint and that the pro-

posed civil penalty, revocation, pension, as the case may be, is a private. Following the establishment of a prima facie case, respondent shall have the burden of presenting and of going forward with any defense to the allegations set forth in the complaint. Each matter of controversy shall be determined by the presiding officer upon a preponderance of the evidence.

§ 22.23 Filing the transcript.

The hearing shall be transcribed verbatim. Promptly following the taking of the last evidence, the reporter shall transmit to the regional hearing clerk the original and as many copies of the transcript of testimony as are called for in the reporter's contract with the Agency, and also shall transmit to the presiding officer a copy of the transcript. A certificate of service shall accompany each copy of the transcript. The regional hearing clerk shall notify all parties of the availability of the transcript and shall furnish the parties with a copy of the transcript upon payment of the cost of reproduction, unless a party can show that the cost is unduly burdensome. Any person not a party to the proceeding may receive a copy of the transcript upon payment of the reproduction fee.

§ 22.26 Proposed findings, conclusions, and order.

Within twenty (20) days after the parties are notified of the availability of the transcript, or within such longer time as may be fixed by the presiding officer, any party may submit for the consideration of the presiding officer proposed findings of fact, conclusions of law, and a proposed rule or order, together with briefs in support thereof. The presiding officer shall set a time by which reply briefs must be submitted. All submissions shall be in writing, shall be served upon all parties, and shall contain adequate references to the record and authorities relied on.

Subpart E—Initial Decision and Motion To Reopen a Hearing

§ 22.27 Initial decision.

(a) *Filing and contents.* The presiding officer shall issue and file with the regional hearing clerk his initial decision as soon as practicable after the period for filing reply briefs under § 22.25 has expired. The initial decision shall contain his findings of fact, conclusions regarding all material issues of law or discretion, as well as reasons therefor, a recommended civil penalty assessment, and a proposed final order. The regional hearing clerk shall forward the initial decision (which includes an accelerated decision or a proposed default order) and

the record of the proceeding to the hearing clerk.

(b) *Amount of civil penalty.* The presiding officer shall determine the dollar amount of the recommended civil penalty to be assessed in the initial decision in accordance with any criteria set forth in the act relating to the proper amount of a civil penalty, and must consider any civil penalty guidelines published under the act. The presiding officer may increase or decrease the assessed penalty from the amount proposed to be assessed in the complaint.

(c) *Effect of initial decision.* The initial decision of the presiding officer shall become the final order of the Administrator within forty-five (45) days after its receipt by the hearing clerk and without further proceedings unless (1) an appeal to the Administrator is taken from it by a party to the proceedings, or (2) the Administrator elects, sua sponte, to review the initial decision.

§ 22.28 Motion to reopen a hearing.

(a) *Filing and content.* A request to reopen a hearing to take further evidence must be made by motion to the presiding officer and filed with the regional hearing clerk at any time after service of the initial decision and prior to the issuance of the final order. Each such motion shall (1) state the specific grounds upon which relief is sought, (2) state briefly the nature and purpose of the evidence to be adduced, (3) show that such evidence is not cumulative, and (4) set forth a good reason why such evidence was not adduced at a hearing.

(b) *Disposition of motion to reopen a hearing.* Within ten (10) days following the service of a motion to reopen a hearing any other party to the proceeding may file with the regional hearing clerk and serve on all other parties an answer thereto. The presiding officer shall announce his intent to grant or to deny such motion as soon as practicable thereafter. The conduct of any proceeding which may be required as a result of the granting of any motion allowed in this section shall be governed by the provisions of the applicable section of these rules.

Subpart F—Appeals and Administrative Review

§ 22.29 Appeal from or review of interlocutory orders or rulings.

(a) *Request for interlocutory appeal.* Except as provided in this section, appeals to the Administrator shall obtain as a matter of right only from a proposed default order, an accelerated decision issued under § 22.20(b)(1), or a decision rendered after an evidentiary hearing. Appeals from other orders or rulings shall lie only if the presiding

officer, upon motion of a party, certifies such orders or rulings to the Administrator on appeal. Requests to the presiding officer for such certification shall be filed in writing within five (5) days of notice of the ruling or service of the order, and shall state briefly the grounds to be relied upon on appeal.

(b) *Availability or interlocutory appeal.* The presiding officer may certify a ruling for appeal to the Administrator when (1) the order or ruling involves an important question of law or policy concerning which there are substantial grounds for difference of opinion; and (2) either (i) an immediate appeal from the order or ruling will materially advance the ultimate termination of the proceeding, or (ii) review after the final order is issued will be inadequate or ineffective.

(c) *Decision.* If the Administrator determines that certification was improvidently granted, or if he takes no action within thirty (30) days of the certification, the appeal is dismissed. When the presiding officer declines to certify an order or ruling to the Administrator on interlocutory appeal, it may be reviewed by the Administrator only upon appeal from the initial decision, except when the Administrator determines, upon motion of a party and in exceptional circumstances, that to delay review would be contrary to the public interest. Such motion shall be made within five (5) days of service of an order or the presiding officer refusing to certify a ruling for interlocutory appeal to the Administrator. Ordinarily, the interlocutory appeal will be decided on the basis of the submissions made by the presiding officer. The Administrator may, however, allow further briefs and oral argument.

(d) *Stay of proceedings.* The presiding officer may stay the proceedings pending a decision by the Administrator upon an order or ruling certified by the presiding officer for an interlocutory appeal. Proceedings will not be stayed except in extraordinary circumstances. Where the presiding officer grants a stay of more than thirty (30) days, such stay must be separately approved by the Administrator.

§ 22.30 Appeal from or review of initial decision.

(a) *Notice of appeal.* (1) Any party may appeal any adverse ruling or order of the presiding officer by filing a notice of appeal and an accompanying appellate brief with the hearing clerk within twenty (20) days after receipt by the hearing clerk of the initial decision. The notice of appeal shall set forth alternative findings of fact, alternative conclusions regarding issues of law or discretion, and a proposed order together with relevant refer-

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ances to the record and the decision. The appellant's brief shall contain a statement of the issues raised for review, a statement of the nature of the case and the facts relevant to the issues presented for review, argument on the issues presented, and a short conclusion stating the precise relief sought, together with appropriate references to the record. The hearing clerk shall serve the notice of appeal and the appellant's brief upon all other parties and amicus curiae.

(2) Within fifteen (15) days of the service of notices of appeal and briefs under paragraph (a)(1) of this section, any other party or amicus curiae may file and serve with the hearing clerk a reply brief responding to argument raised by the appellant, together with references to the relevant portions of the record, initial decision, or opposing brief. Reply briefs shall not, however, raise additional arguments.

(b) *Sua sponte* review by the Administrator. Whenever the Administrator determines *sua sponte* to review an initial decision, the hearing clerk shall serve notice of such intention on the parties within forty-five (45) days after receipt of the initial decision. The notice shall include a statement of issues to be briefed by the parties and a time schedule for the service and filing of briefs.

(c) *Scope of appeal or review.* The appeal of the initial decision shall be limited to the issues raised by the appellant unless the Administrator determines that additional issues should be argued. If the Administrator determines that additional issues should be argued, he shall give counsel for the parties reasonable written notice of such determination to permit preparation of adequate argument.

(d) *Argument before the Administrator.* The Administrator may, upon request of a party or *sua sponte*, assign a time and place for oral argument after giving consideration to the convenience of the parties.

Support G—Final Order on Appeal § 22.31 Final order on appeal.

(a) *Contents of the final order.* When an appeal has been taken or the Administrator issues a notice of intent to conduct review *sua sponte*, the Administrator shall issue a final order as soon as practicable after the filing of all appellate briefs or oral argument, whichever is later. The Administrator shall adopt, modify or set aside the findings and conclusions contained in the decision or order being reviewed, and shall set forth in the final order the reasons for his actions. The Administrator may, in his discretion, increase or decrease the assessed penalty from the amount recommended to be assessed in the decision or order being reviewed.

(b) *Payment of a civil penalty.* The respondent shall pay the full amount of the civil penalty assessed in the final order within sixty (60) days after receipt of the final order unless otherwise agreed by the parties. Payment shall be made by forwarding to the regional hearing clerk a cashier's check or certified check in the amount of the penalty assessed in the final order, payable to the United States of America.

§ 22.32 Motion to reconsider a final order.

Motions to reconsider the final order shall be filed within ten (10) days after service of the final order. Every such motion must set forth the matters claimed to have been erroneously decided and the nature of the alleged errors. Such motion shall not stay the effectiveness of the final order unless the Administrator provides otherwise.

Support H—Supplemental Rules of Practice Governing Administrative Assessment of Civil Penalties Under the Toxic Substances Control Act

§ 22.33 Supplemental rules of practice governing administrative assessment of civil penalties under the Toxic Substances Control Act.

(a) *Scope of these supplemental rules.* These supplemental rules of practice shall govern, in conjunction with the consolidated rules of practice (40 CFR Part 22), all formal adjudications for the assessment of any civil penalty conducted under section 16(a) of the Toxic Substances Control Act (15 U.S.C. 2615(a)). Where inconsistencies exist between these supplemental rules and the consolidated rules, these supplemental rules shall apply.

(b) *Subpoenas.* (1) The attendance of witnesses or the production of documentary evidence may be required by subpoena. The presiding officer may grant a request for a subpoena upon a showing of (i) the grounds and necessity therefor, and (ii) of the materiality and relevancy of the evidence to be produced. Requests for the production of documents shall describe with specificity the documents sought.

(2) Subpoenas shall be served in accordance with section 22.03(b)(1) of the consolidated rules of practice.

(3) Witnesses summoned before the presiding officer shall be paid the same fees and mileage that are paid witnesses in the courts of the United States. Fees shall be paid by the party at whose instance the witness appears. Where a witness appears pursuant to a request initiated by the presiding officer, fees shall be paid by the agency.

APPENDIX

Region I, John F. Kennedy Federal Building, Boston, Mass. 02203.
Region II, 26 Federal Plaza, New York, N.Y. 10007.
Region III, Curtis Building, 6th and Walnut Streets, Philadelphia, Pa. 19106.
Region IV, 345 Courtland Street N.E., Atlanta, Ga. 30303.
Region V, 230 South Dearborn Street, Chicago, Ill. 60604.
Region VI, First International Building, 1201 Elm Street, Dallas, Tex. 75202.
Region VII, 1735 Baltimore, Kansas City, Mo. 64105.
Region VIII, 1860 Lincoln Street, Denver, Colo. 80202.
Region IX, 215 Fremont Street, San Francisco, Calif. 94105.
Region X, 1209 6th Avenue, Seattle, Wash. 98101.

(CFR Doc. 75-21768 Filed 6-3-78; 3:45 am)

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IX

In re) Docket No. TSCA-IX-0020
NEVADA POWER COMPANY,) COMPLAINT
AND
Respondent.) NOTICE OF OPPORTUNITY
FOR HEARING

I

COMPLAINT

This is a civil administrative action instituted pursuant to Section 16(a) of the Toxic Substances Control Act (TSCA), 15 USC 2615(a). The Complainant is the Director, Enforcement Division, United States Environmental Protection Agency (EPA), Region IX. The Respondent is Nevada Power Company and has a place of business in Las Vegas, Nevada.

This Complaint serves as notice that the Complainant has reason to believe that Respondent has violated Section 15 of TSCA, 15 USC 2614, as follows:

Count I

1. 40 CFR 761.10(b) states that any PCB mixture shall be disposed of in an incinerator (40 CFR 761.40 of Annex I).

2. 40 CFR 761.10(e)(1) states that spills and other uncontrolled discharges of PCB mixtures constitute the disposal (40 CFR 761.2(e)) of PCB mixtures.

3. On or about February 19, 1979, Respondent operated a capacitor (40 CFR 761.2(c)), which contained a PCB mixture (40 CFR 761.2(w)), at or near 5816 Iris Avenue, Las Vegas, Nevada.

4. On or about February 19, 1979, the capacitor operated by Respondent spilled or discharged the PCB mixture in violation of 40 CFR 761.10(b) and 15 USC 2416 (1)(C).

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Count II

1. 40 CFR 761.10(b)(5), 761.10(c)(4), and 761.10(d)(2) state that when storage is desired prior to disposal, PCB's shall be stored in a facility which complies with Annex III.

2. 40 CFR 761.42(b)(1)(i) of Annex-III states that facilities used for the storage of PCB's, which are designated for disposal, shall have an adequate roof and walls to prevent rain water from reaching the stored PCB's.

3. On or about March 1, 1979, Respondent operated a facility used for the storage of PCB's (40 CFR 761.2(c)), which were designated for disposal, at or near 2515 Industrial Road, Las Vegas, Nevada.

4. On or about March 1, 1979, the PCB storage facility operated by Respondent did not have a roof or walls in violation of 40 CFR 761.42(b)(1)(i) of Annex III and 15 USC 2614(1)(C).

Count III

1. 40 CFR 761.42(b)(1)(ii) of Annex III states that facilities used for the storage of PCB's, which are designated for disposal, shall have an adequate floor which has continuous curbing with a minimum six inch high curb.

2. On or about March 1, 1979, the PCB storage facility operated by Respondent did not have a floor or curbing in violation of 40 CFR 761.42(b)(1)(ii) of Annex III and 15 USC 2614(1)(C).

Count IV

1. 40 CFR 761.42(c)(7) of Annex III states that PCB articles (40 CFR 761.2(c)) and PCB containers (40 CFR 761.2(u)) shall be dated when they are placed in storage.

2. On or about March 1, 1979, PCB articles and PCB containers, which Respondent had placed in its PCB storage facility, were not dated in violation of 40 CFR 761.42(c)(7) of Annex III and 15 USC 2614(1)(C).

Count V

1. 40 CFR 761.42(c)(8) of Annex III states that owners or operators of PCB storage facilities shall establish and maintain records as provided in Annex VI.

2. 40 CFR 761.45(a)(1) of Annex VI states that each owner or operator of a facility, which contains at least 45 kilograms of PCB mixtures or one or more PCB transformers or 50 or more PCB large high or low voltage capacitors, shall develop and maintain records of the dates when PCB's are placed into storage for disposal.

3. On or about March 1, 1979, the facility operated by Respondent contained at least 45 kilograms of PCB mixtures or one or more PCB transformers or 50 or more PCB large high or low voltage capacitors.

4. On or about March 1, 1979, Respondent had not developed and maintained records of the dates when PCB's were placed into storage for disposal in violation of 40 CFR 761.45(a)(1) of Annex VI and 15 USC 2614(1)(C) and 2614(3)(A).

II

PROPOSED CIVIL PENALTY

Section 16(a) of TSCA, 15 USC 2615(a), authorizes a civil penalty of up to \$25,000 per day for each violation of Section 15 of TSCA, 15 USC 2614. Based on the facts and the nature, circumstances, extent, and gravity of the violations, as well as Respondent's ability to pay, ability to continue to do business, history of prior violations, and degree of culpability, EPA proposes to assess the following civil penalty:

1 Count I
2 15 USC 2614(1) (C)
3 40 CFR 761.10(b)
4 Spill or discharge of PCB mixture.....\$ 5,000

5 Count II
6 15 USC 2614(1) (C)
7 40 CFR 761.42(b) (1) (i) of Annex III
8 PCB storage facility with no roof or walls.....\$ -0-

9 Count III
10 15 USC 2614(1) (C)
11 40 CFR 761.42(b) (1) (ii) of Annex III
12 PCB storage facility with no floor or curbing.....\$ -0-

13 Count IV
14 15 USC 2614(1) (C)
15 40 CFR 761.42(c) (7) of Annex III
16 PCB articles and PCB containers not dated.....\$ - 0 -

17 Count V
18 15 USC 2614(1) (C) and 2614(3) (A)
19 40 CFR 761.45(a) (1) of Annex VI
20 No records of PCB's in storage.....\$ - 0 -
21 Total Proposed Civil Penalty.....\$ 5,000

22 III.

23 NOTICE OF OPPORTUNITY FOR HEARING

24 You have the right to request a hearing on any material fact
25 contained in the Complaint or the amount of the proposed penalty.
26 If you wish to request a hearing and avoid being found in default,
27 you must file a written Answer to the Complaint with the Region IX
28 Hearing Clerk, EPA Region IX, 215 Fremont Street, San Francisco,
29 California 94105, within fifteen (15) days of your receipt of the
30 Complaint. The Answer must clearly and directly admit, deny, or
31 explain each of the factual allegations contained in the Complaint
32 with regard to which you have any knowledge. A failure to admit,

- 4 -

1 deny, or explain any material fact allegation will constitute an
2 admission of the allegation. The Answer must also state (1) the
3 circumstances or arguments which constitute the grounds of defense,
4 (2) the facts which you intend to place at issue, and (3) whether
5 a hearing is requested.

6 If you fail to file a written Answer within fifteen (15)
7 days of your receipt of the Complaint, you may be found in default.
8 Your default will constitute an admission of all facts alleged in
9 the Complaint and a waiver of your right to a hearing. The
10 penalty proposed in the Complaint will be imposed without further
11 proceedings.

12 Any hearing that you request will be held in the EPA Region IX
13 offices in San Francisco, California, unless there is good cause
14 to hold it at another location. The hearing will be conducted in
15 accordance with the provisions of the Administrative Procedure
16 Act, 5 USC 552 et seq., and the Rules of Practice, 40 CFR Part 22
17 (43 FR 34730), a copy of which accompanies the Complaint.

18 IV

19 SETTLEMENT CONFERENCE

20 Whether or not you request a hearing, you may confer infor-
21 mally with EPA to discuss the alleged facts, violations, or
22 amount of the proposed penalty. An informal conference does not,
23 however, affect your obligation to file a written Answer within
24 fifteen (15) days of your receipt of the Complaint.

25 Any settlement reached as a result of an informal conference
26 will be embodied in a written Consent Agreement and Final Order.
27 The issuance of the Consent Agreement and Final Order will consti-
28 tute a waiver of your right to a hearing on any matter to which
29 you stipulated.

30 ---

31 ---

32 ---

1 If a settlement cannot be reached through an informal con-
2 ference, the filing of a written Answer within fifteen (15) days
3 of your receipt of the Complaint will preserve your right to a
4 hearing.

5 EPA encourages all parties against whom a penalty is proposed
6 to explore the possibility of settlement. To request an informal
7 conference, you should contact Keith Takata, EPA Region IX,
8 Enforcement Division, 215 Fremont Street, San Francisco, California
9 94105, telephone number (415) 556-8008.

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Dated: 18 SEP 1979

Clyde B. Eller
Clyde B. Eller
Director
Enforcement Division

SAFETY DEPARTMENT

NEVADA POWER COMPANY

TO: Distribution Listed Below

DATE: 11/23/79

FROM: SAFETY DIRECTOR, D. Fabbi *df*

SUBJECT: PCB's - Questions & Answers/Regulations

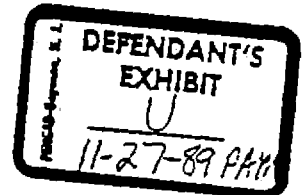
Attached is information regarding current EPA regulations relative to PCB's. The information is presented in a question/answer format. This may be useful in a number of ways, such as, dealing with the public or media, interpreting the standards, or developing further methods of control or disposal programs, etc...

DF/re

cc: J. McCarthy W. Henson
 C. Kaiser
 R. Brown W. McGarry
 D. Crotta R. Slate
 S. Claeys J. Strobel
 K. Grant R. Whatley
 R. Hall J. Zornes

NO JOB IS SO URGENT - OR NO SERVICE SO IMPORTANT - THAT IT PREVENTS US FROM TAKING THE TIME TO DO OUR WORK SA

Exhibit
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N. 09905

A000291



Polychlorinated Biphenyls

PCB's

Questions & Answers

November 23, 1979

A000292

N, 09906

INTRODUCTION

On May 31, 1979 in the Federal Register (44 FR 31514) the U.S. Environmental Protection Agency published the Final Rule for Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions. This information is presented in a non-technical manner, deals with the Rule's coverage and requirements. Its question-and-answer format is categorized into the following areas.

<u>Q & A Category</u>	<u>Pages</u>
Introductory Information	2-3
General Rule Provisions	4-5
Capacitors	6
Transformers	7-11
Labeling	12-13
Testing	13-14
Storage	14-16
Spills	16-17
Recordkeeping	17-18
Disposal	19-23
PCBs in the Workplace	23-24
Nevada Power Specifics and Program .	25-26

(1) WHAT ARE PCBs?

The term PCBs is short for polychlorinated biphenyls. PCBs belong to a broad family of organic chemicals known as chlorinated hydrocarbons. PCBs are produced by attaching chlorine molecules to a biphenyl molecule. Although PCBs may be produced naturally in the environment, almost all PCBs in existence today have been synthetically manufactured.

(2) WHO MANUFACTURED PCBs?

Monsanto Corporation was the principal manufacturer of PCBs in the United States. They began production of PCBs in 1929; in 1977 they voluntarily terminated production because of the widespread environmental concerns about PCBs.

(3) WHAT TRADE NAMES WERE PCBs SOLD UNDER?

The tradename Monsanto Corporation sold PCBs under was "Askarel". However, companies who used PCBs in the manufacture of transformers and capacitors, and for other uses, often used other tradenames. The following list is representative of PCB Tradenames: Aroclor, Pydraul, Therminol, Pyroclor, Santotherm, Pyralene, Pyranol, Inerteen, Asbestol, Chlorextol, Diachlor, Dykanol, Elemex, Hyvol, No-Flamol, Saf-T-Kuhl, Aroclor B, Clorinol, Clorphen, Eucarel.

(4) WHAT ARE THE PHYSICAL AND CHEMICAL PROPERTIES OF PCBs?

PCBs have a heavy liquid, oil-like consistency, and weigh 10-12 pounds per gallon. The properties which made them commercially attractive include: a high degree of chemical stability, low solubility in water, low vapor pressure, low flammability, high heat capacity, low electrical conductivity, and a favorable dielectric constant.

(5) HOW ARE PCBs USED?

The primary use of PCBs has been in "closed" or "semi-closed" systems in electrical transformers, capacitors, heat transfer systems, and hydraulic systems. PCBs have also been used in paints, adhesives, caulking compounds, plasticizers,

inks, lubricants, carbonless copy paper, sealants, coatings, and dust control agents.

Most of the PCBs marketed in the United States are still in service, primarily in electrical equipment.

(6) WHY ARE PCBs HARMFUL TO HUMAN HEALTH AND THE ENVIRONMENT?

PCBs are harmful because once released into the environment they do not break apart into new chemical arrangements, instead they bioaccumulate in organisms throughout the environment. In addition, PCBs biomagnify in the food chain -- that is, they accumulate in the tissues of living organisms and as they move up the food chain towards man their concentration increases. These facts are significant because PCBs have been shown to cause chronic (long-term) toxic effects in many species even when the exposed to very low concentrations.

(7) WHAT ARE THE KNOWN HEALTH EFFECTS OF PCBs?

There are well documented tests which show PCBs cause, among other things, reproductive failures, gastric disorders, skin lesions, and tumors in laboratory animals.

Studies of workers exposed to PCBs have shown a number of symptoms and adverse effects including, but not limited to, chloracne and other epidermal disorders, digestive disturbances, jaundice, impotence, throat and respiratory irritations, and severe headaches.

(8) WHAT ACTION HAS EPA TAKEN AGAINST PCBs?

In 1976, Congress enacted the Toxic Substances Control Act (TSCA). Section 6(e) of this law requires EPA to establish rules to: (1) govern the disposal and marking of PCBs; and (2) prohibit, with certain exceptions, the manufacture, processing, distribution in commerce, and non-totally enclosed use of PCBs.

Final Marking and Disposal Rules appeared in the Federal Register on February 17, 1978 (clarifying amendments to this Rule appeared in the August 2, 1978 Federal Register).

On June 7, 1978, the Proposed PCB Ban Rule was published in the Federal Register. The Final PCB Ban Rule appeared in the Federal Register on May 31, 1979; this Rule supersedes the February 17, 1978 PCB regulation and takes effect on July 2, 1979.

(9) WHAT DOES THE MAY 31, 1979 PCB BAN RULE DO?

Specifically, the rule:

- (1) prohibits the manufacturing, processing, distribution in commerce, and the use of PCBs except in a totally enclosed manner after July 2, 1979;
- (2) provides authorizations for certain processing, distribution in commerce, and use of PCBs in a non-totally enclosed manner;
- (3) prohibits, unless exempted by EPA, all manufacturing of PCBs after July 2, 1979;
- (4) prohibits, unless exempted by EPA, all processing and distribution in commerce of PCBs after July 1, 1979.

Also, the February 17, 1978 PCB Disposal and Marking Rule requirements are integrated into this PCB Ban Rule. Therefore, with the total scope of the PCB regulation -- from labeling to production ban to disposal -- now appearing in the May 31, 1979 Federal Register, this publication supersedes all earlier PCB regulations upon its July 2, 1979 effective date.

EPA has also published in the May 31, 1979 Federal Register a notice which explains how to file for an exemption from the July 2, 1979 bans on processing and distribution in commerce of PCBs. Petitions for exemptions must be filed by July 1, 1979. EPA earlier published procedures for filing petitions for exemption from the January 1, 1979 prohibition on manufacturing of PCBs. These procedures can be found in the November 1, 1978 Federal Register (43 FR 50905).

(10) DOES THIS RULE APPLY TO ALL PCBs OR IS THERE A CUT-OFF POINT BASED ON THE CONCENTRATION OF PCBs?

In order to practically implement this rule (i.e., exceptions, disposal and marking requirements), EPA had to adopt a PCB concentration cut-off point for regulation. Therefore, the final rule applies to any substance, mixture, or item with 50 ppm or greater PCB; wherever the term "PCB" or "PCBs" is used in the rule, it means PCBs at a concentration of 50 ppm or greater, unless otherwise specified.

This 50 ppm is a change from the February 17, 1978 Disposal and Marking Rule which set a 500 ppm cut-off. By lowering the PCB cut-off point from 500 ppm to 50 ppm, it will substantially increase health and environmental protection --- approximately,

controlled, as well as 100,000 to 500,000 p is per year of new PCBs.

- (11) IS THERE ANYTHING WHICH CONTAINS LESS THAN 50 PPM PCBs WHICH IS BANNED FROM BEING USED UNDER THIS RULE?

Yes, waste oil containing any detectable concentration of PCBs is forbidden from being used as a sealant, coating, or dust control agent. To permit the use of waste oil with any PCB-contamination to be used in road oiling, pipe coating, or vegetation spraying would cause PCBs to directly enter the air and waterways, which could introduce them into the food chain.

- (12) WHAT IS THE DIFFERENCE BETWEEN "MANUFACTURING OF PCBs" AND "PROCESSING OF PCBs"?

The actual creation of the chemical substance PCB, or a substance contaminated with PCBs (e.g., PCBs as an impurity), is the "manufacturing of PCBs".

The production of PCB Articles and PCB Equipment is considered "processing of PCBs", and involves the use of existing PCBs. Processing PCBs includes such activities as placing manufactured PCBs into capacitors or transformers.

- (13) WHAT IS CONSIDERED A PCB ARTICLE? PCB EQUIPMENT? PCB ITEM?

An article whose surface is directly contacted by PCBs is considered a "PCB Article". Examples include capacitors, transformers, electric motors, pumps, and pipes.

Equipment whose surface is not directly contacted by PCBs, but contains a PCB article, is considered "PCB Equipment". Examples include televisions, air conditioners, microwave ovens, electronic equipment, and fluorescent light ballasts and fixtures.

"PCB Item" is a collective term used throughout the Rule to refer to PCB Equipment/Articles/Containers/Article Containers.

- (14) WHAT EFFECT DOES THE PCB BAN RULE HAVE ON PCB ARTICLES? PCB EQUIPMENT?

After July 2, 1979, PCB Articles can no longer be produced because the production is not totally enclosed. However, since the production of PCB Equipment is considered totally enclosed processing, this can continue until July 1, 1979 under the Rule; in order to continue PCB Equipment production after that date, an exemption must be obtained from EPA.

CAPACITORS

- (15) HOW DO THESE RULES AFFECT CAPACITORS? CAN I CONTINUE TO USE MY PCB CAPACITORS?

Yes, you can continue to use your PCB capacitors for their useful life. The primary effect of the new prohibition rules is to terminate the manufacture of any new PCB capacitors.

- (16) WHAT ABOUT THE DISPOSAL OF PCB CAPACITORS?

These rules continue the provisions of the PCB Disposal and Marking Rule published in the February 17, 1978 Federal Register. Large PCB capacitors must be disposed of in an EPA approved chemical waste landfill or incinerator. After January 1, 1980 all large PCB capacitors will have to be incinerated in special EPA approved incinerators.

Special disposal is not required for small capacitors --- except those waste capacitors owned by PCB capacitor or PCB equipment producers.

- (17) WHAT IS THE DIFFERENCE BETWEEN LARGE AND SMALL CAPACITORS?

Small capacitors have less than 3 pounds of contained dielectric fluid; large capacitors have 3 pounds or more of dielectric fluid.

- (18) I HAVE PCB CAPACITORS THAT ARE TEMPORARILY OUT OF SERVICE; CAN THEY BE PUT BACK INTO SERVICE?

Yes, but they will be subject to disposal requirements at a later date.

- (19) I NEED SPECIAL PCB CAPACITORS TO SERVICE MY PCB EQUIPMENT. WILL I BE ABLE TO BUY REPLACEMENT PCB CAPACITORS?

If suppliers receive an exemption from EPA, they can sell existing stocks of PCB capacitors to service existing PCB equipment.

TRANSFORMERS

- (20) UNDER THE FINAL BAN RULE, THE USE OF PCBs IN TRANSFORMERS IS CONSIDERED USE IN A TOTALLY ENCLOSED MANNER. DOES THIS MEAN I CAN CONTINUE TO USE MY TRANSFORMERS CONTAINING PCBs? IF SO, FOR HOW LONG?

Transformers containing PCBs can be used as long as they perform their intended function and do not leak PCBs into the environment.

- (21) IN ORDER TO GET THE FULL USEFUL LIFE OUT OF LIQUID FILLED TRANSFORMERS, THEY MUST BE SERVICED OR REPAIRED PERIODICALLY. ARE THESE ACTIVITIES PERMITTED UNDER THE RULE? ARE THERE ANY RESTRICTIONS?

Servicing of these transformers is authorized until July 1, 1984. EPA will consider the necessity of extending the authorized period prior to the 1984 termination date. Special restrictions are dependent upon the concentration of PCBs in the transformer, and whether PCBs are sold during the servicing activities.

There are four categories of transformers considered in this regulation and the restrictions and special conditions are easier to understand in the context of these categories.

- (22) WHAT ARE THE 4 TRANSFORMER CATEGORIES? WHAT IS THE SIGNIFICANCE OF EACH?

The four categories of transformers established by the PCB Rule are:

- (1) PCB Transformers containing PCBs at a concentration of 500 PPM or greater;
- (2) PCB-Contaminated Transformers containing between 50 PPM and 500 PPM PCB;
- (3) Non-PCB Transformers containing less than 50 PPM PCB;
- (4) Railroad Transformers used in electric railroad locomotives and self-powered cars that contain PCB fluid.

The transformer categories are significant, because under the Rule each is subject to different disposal, servicing (including rebuilding), and storage requirements.

requirements. . .ately; the other 3 categories are discussed simultaneously..

(23) HOW DO I DETERMINE WHICH OF THE FOUR TRANSFORMER CATEGORIES I HAVE?

A transformer must be assumed to be a PCB Transformer if: (1) the nameplate indicates that the transformer contains PCB dielectric fluid; (2) the owner or operator has any reason to believe that the transformer contains PCB dielectric fluid; or (3) the transformer's dielectric fluid has been tested and found to contain 500 ppm or greater PCB. If a transformer does not have a nameplate or there isn't any information to indicate the type of dielectric fluid in it, the transformer must be assumed to be a PCB Transformer.

If a transformer is tested and found to contain less than 500 ppm PCB, it will then fall into one of the other appropriate categories.

A transformer can be reclassified as a Non-PCB Transformer if its dielectric fluid has been tested or otherwise verified to contain less than 50 ppm PCB. Testing Transformers in order to classify them as Non-PCB Transformers does not significantly change the actions required by the Rule. If your transformers are proven Non-PCB Transformers you should take precautions to see that they aren't later contaminated during servicing with PCB fluid over 50 ppm.

(24) WHY SHOULD I ASSUME THAT MY MINERAL OIL TRANSFORMER IS A PCB-CONTAMINATED TRANSFORMER? IF I GO TO THE EXTRA TROUBLE AND EXPENSE TO TEST MY TRANSFORMER IN ORDER TO CLASSIFY IT AS A NON-PCB TRANSFORMER, WHY WON'T MY REQUIREMENTS UNDER THE RULE BECOME SIGNIFICANTLY SIMPLER?

Current data shows that 25-40% of the existing mineral oil transformers are contaminated with 50 ppm or more of PCBs.

No clear pattern exists to explain why one transformer is contaminated and another one is significantly less contaminated. This means that testing all transformers would be necessary in order to be certain about the appropriate category. This would be extremely expensive. Therefore, the requirements in the Rule for servicing, disposal, labeling, and use have been designed to make this testing step largely unnecessary.

The only servicing restriction on PCB-Contaminated Transformers is that companies servicing transformers owned by others and who sell PCB-contaminated mineral oil to their customers must

receive an exemption from EPA. If they sold only uncontaminated mineral oil (less than 50 ppm PCBs), then no exemption would be needed.

The disposal requirements for PCB-contaminated fluids are specific (high efficiency boilers, incineration or chemical waste landfills). However, the disposal options for fluids from Non-PCB Transformers are not much greater, because of the broad prohibition on using waste containing PCBs for dust control, sealant or coating purposes.

There are no labeling requirements for either transformer categories (PCB-Contaminated or Non-PCB Transformers), and no use restriction differences.

(25) HOW WOULD TRANSFORMERS WHICH USE PCB-FREE MINERAL OIL DIELECTRIC FLUID BE CATEGORIZED?

Because of the widespread contamination of mineral oil dielectric fluid transformers, they must be assumed to be PCB-Contaminated Transformers. Even if PCB-free dielectric fluid was added to an existing transformer, you couldn't be certain that PCB contamination in the transformer would not contaminate the new fluid to a level above 50 ppm PCB.

You, of course, have the option of testing the new aggregate dielectric fluid in the transformer to determine if the PCB concentration is below 50 ppm, in which case it could be considered a Non-PCB Transformer.

(26) CAN I RECLASSIFY MY PCB TRANSFORMER IF I REDUCE ITS PCB CONCENTRATION?

PCB Transformers can be reclassified to PCB-Contaminated Transformers by draining and refilling them with non-PCB dielectric fluid. Before they can be reclassified the transformers must be tested and found to contain less than 500 ppm PCB after at least 3 months of in-service use.

If the PCB concentration was successfully reduced below 50 ppm, then the transformer can be reclassified to a Non-PCB Transformer.

(27) WHAT TYPE OF SERVICING CAN I DO ON MY TRANSFORMER?

Routine servicing of transformers (i.e., testing the dielectric fluid, filtering the fluid, removal of some fluid and then returning or replacing it, replacing gaskets) in any of the categories will result in minimal exposures to PCBs and allow the

use of most servicing transformers throughout their lifetime. EPA has decided that this activity doesn't present an unreasonable risk to human health and the environment.

However, any servicing (including rebuilding) of PCB Transformers that involves removing the coils from the casing is prohibited by the Ban Rule. Removing the coils substantially increases PCB exposure, therefore, EPA concludes this servicing to be an unreasonable risk. EPA believes the cost of this prohibition (about \$14 million the first year and steadily less each year after) is justified by the increased risks which would otherwise occur to human health and the environment.

(28) CAN I REBUILD MY TRANSFORMERS?

Rebuilding a transformer would involve one or more of the following: draining the transformer, removing and disassembling the core, reworking the coil or rewinding a new coil, reassembling the core, and refilling the transformer with new fluid.

EPA permits the rebuilding only of PCB-Contaminated Transformers (containing between 50 ppm and 500 ppm PCB), and, of course, Non-PCB Transformers. If your transformer is classified as a PCB Transformer (containing 500 ppm or greater PCB), it cannot be rebuilt unless it is first reclassified to a PCB-Contaminated Transformer.

EPA decided to permit rebuilding of PCB-Contaminated Transformers, because the exposure to PCB is relatively low and the economic impact of not permitting this activity would be very high.

(29) CAN I SERVICE MY OWN TRANSFORMERS?

EPA has decided to authorize this activity, which is considered use, for persons who service their own transformers until July 1, 1984.

(30) CAN I HAVE A SERVICE SHOP WORK ON MY TRANSFORMER?

Yes, you can have work done on your transformer without receiving an exemption from EPA provided the shop does not add any PCB fluid. If PCB fluid (50 ppm PCB or greater) needs to be added, the shop can add your fluid without obtaining an exemption. However, if the service shop adds their PCB fluid to your transformer, they must get an exemption to do so after July 1, 1979.

(31) CAN I REUSE MY DIELECTRIC FLUID?

Dielectric fluid can be reused as long as it is used in either the transformer that it came from or in a transformer which had a higher concentration of PCBs than the replacement fluid.

(32) WHAT FLUIDS CAN I USE WHEN I RETROFILL MY TRANSFORMER?

Dielectric fluids containing less than 500 ppm PCBs can be used to refill transformers. However, dielectric fluids containing less than 500 ppm PCB under no circumstances can be mixed with fluids containing 500 ppm or greater PCBs. In other words, the deliberate dilution of PCB Transformers is prohibited. A PCB Transformer must be drained, refilled, and tested after it was retrofilled before it can be reclassified as a PCB-Contaminated Transformer. It should be noted that PCB Transformers are usually retrofilled with fluids that have fire resistant properties similar to PCBs.

(33) ARE THERE ANY RESTRICTIONS ON WHO CAN SELL ME DIELECTRIC FLUID?

After July 1, 1979, only those persons who have obtained exemptions from EPA can distribute (and sell) PCB dielectric fluid.

(34) CAN I SELL MY DIELECTRIC FLUID TO A WASTE OIL DEALER?

Dielectric fluid containing greater than 50 ppm PCB cannot be sold to a waste oil dealer unless the dealer is to dispose of it in accordance with the regulation. Dielectric fluid with concentrations of less than 50 ppm can be sold to a waste oil dealer as long as it will not be used as a sealant, coating, or dust control agent.

(35) CAN I SCRAP MY TRANSFORMER OR SELL IT TO SOMEONE TO SCRAP?

If your transformer is a PCB Transformer, you cannot scrap or sell your transformer to someone else to scrap. You must dispose of it in an approved chemical waste landfill. On the other hand, if the transformer is a PCB-Contaminated or Non-PCB Transformer, once the fluid is drained, the transformer can be scrapped or sold for scrap.

(36) CAN USEABLE TRANSFORMERS BE SOLD BY PRESENT OWNERS?

Yes, provided the seller had originally obtained the transformer for use and not resale --- and the buyer does not purchase the useable PCB transformers for resale, but rather uses them himself. No exemption from EPA is required for such sales.

(37) WHAT NEEDS A LABEL?

Most PCB Items (including PCB Containers, PCB Article Containers, PCB Articles, PCB Equipment, and PCB Transport Vehicles) that contain 50 ppm or greater PCBs must be labeled. This labeling requirement is a modification from the February 17, 1978 Disposal and Marking Regulation which applied to PCB Items that contain 500 ppm or greater PCBs. To provide sufficient time to identify and mark these additional items containing between 50 and 500 ppm PCB, the final May 1979 Rule allows until October 1, 1979 for labeling requirements to be met.

(38) DO ALL TRANSFORMERS CONTAINING PCBs HAVE TO BE LABELED?

PCB Transformers, containing 500 ppm or greater PCB, are required to be labeled. PCB-Contaminated Transformers, containing between 50 and 500 ppm PCB, are not required to be labeled. The cost of marking a very large number of PCB-Contaminated Transformers while they are in service would be extremely high (approximately \$10 for each of the 35 million transformers).

An unmarked transformer is automatically assumed to be a PCB-Contaminated Transformer. However, if a transformer has no nameplate information but there is a reasonable suspicion that PCBs may be present above 500 ppm --- the transformer should be labeled as a PCB Transformer until the PCB content can be verified.

(39) WHERE DO I HAVE TO PUT THE LABELS?

All labels (or marks) are to be put on the exterior of PCB Items and transport vehicles in a place that they can be easily seen and read by anyone inspecting or servicing them.

(40) THERE ARE A LOT OF PCB CAPACITORS AND EQUIPMENT CONTAINING THESE CAPACITORS IN USE. DO THEY ALL HAVE TO BE LABELED?

The requirements for labeling capacitors are primarily related to disposal; the labels serve as a positive reminder regarding disposal. All large, high voltage PCB capacitors have to be labeled, including those in service. Large, low voltage capacitors have to be labeled when they are taken out of service for disposal.

Small capacitors do not have to be labeled. Equipment containing PCB capacitors does not have to be labeled unless the capacitor is a large, high voltage type or if the equipment was produced after January 1, 1979 and contains a small PCB capacitor.

- (41) DO I HAVE TO LABEL A PCB CAPACITOR THAT IS ON A POLE OR IN A SIMILAR INACCESSIBLE LOCATION?

If a PCB capacitor is installed in a "protected" area (e.g., on a power pole, or structure, or behind a fence) the pole, structure, or fence is to be labeled in a place easily seen by interested persons, such as servicemen.

- (42) DOES EPA SUPPLY LABELS FOR PCB CONTAINERS OR PCB ARTICLES AND EQUIPMENT? DOES EPA PROVIDE NAMES OF SOURCES FOR SUCH PCB LABELS?

EPA does not supply any PCB labels. However, the Agency knows of two sources from which you can obtain the required labels: LABELMASTER, 7525 North Wolcott Ave., Chicago, Illinois 60626, phone: 312-973-5100 -- to place only orders call toll free 800-621-5808 (except in Illinois); W.H. BRADY CO., Facilities, Identification, Products Division, 727 W. Glendale Ave., Milwaukee, Wisconsin, phone: 414-332-8100 (X624).

Printing shops who produce labels would also be potential sources for these labels. The label format and sizes are included in the regulation.

TESTING

- (43) IS THERE AN EPA APPROVED TESTING AND SAMPLING PROCEDURE FOR PCB DETECTION?

A variety of procedures exist for determining PCB concentrations in various media such as water, air, soil, mineral oil, pigments, etc. EPA has already made available through its Regional Offices copies of test procedures for PCBs in air, soil, water, and sediments. EPA is also preparing additional information on test procedures for PCBs in oils; this information will also be available from EPA Regional Offices. In addition, copies of these procedures can be obtained from EPA's Office of Industry Assistance. (See the "Contacts for Information" Section of this Booklet on how to obtain this information.)

(44) WHAT EQUIPMENT IS AVAILABLE TO DETECT PCBs?

There is a simple field test for detecting PCBs. It is usually done using gas chromatography/electron capture. The best solution would be to contact an experienced chemical laboratory in your area that could perform such tests.

(45) ARE THERE EPA-APPROVED LABS TO ANALYZED SAMPLES OF PCBs?

No, EPA does not have a program for recommending or approving analytical laboratories.

STORAGE

(46) WHAT KINDS OF CONTAINERS ARE APPROPRIATE FOR STORAGE?

The May 31, 1979 Final Rule permits 5 container types (5, 5B, 6D, 17C and 17E) which comply with Department of Transportation (DOT) specifications set out in 49 CFR 173.346, to be used to store liquid PCBs. Most of industry already is using these containers for PCB storage and handling.

(47) CAN LARGE CONTAINERS, SUCH AS STORAGE TANKS, BE USED FOR THE STORAGE OF PCB LIQUIDS?

EPA decided in the Final Rule to permit large containers, such as storage tanks, to be used to store bulk PCB liquids. This is to allow safe transfer and storage of large PCB liquid quantities; in addition, reduce storage costs. In other words, the transfer of stored bulk PCBs from tanks to other tanks or tank trucks will lessen the spill risks as opposed to having to transfer these large quantities from a number of smaller storage drums into transfer tanks.

These storage tanks must meet design and construction standards adopted by OSHA (29 CFR 1910.106). Also the storage facilities must have a spill prevention control and counter measure plan similar to the plans required for oil spill prevention.

Owners and operators of bulk storage facilities will have to keep records of the amounts added to and removed from bulk containers. These records will be important in tracing waste shipments and enforcing the disposal and storage requirements.

Yes, liquid PCB wastes, such as contaminated soil be temporarily stored for up to 30 days.

- (49) CAN PCB LIQUIDS OF LOW CONCENTRATION BE TEMPORARILY STORED? OF HIGH CONCENTRATION?

Low concentration PCB liquids (50 to 500 ppm) can be temporarily stored for up to 30 days. All temporary storage areas must have a spill prevention control and counter measure plan. However, the final rule does not allow temporary storage for high concentration PCB liquids (above 500 ppm) because of the potential harm from a spill.

- (50) I HAVE A SMALL QUANTITY OF PCBs (I.E., A FEW SOAKED RAGS AND 1 GALLON OF PCBs IN AN APPROVED CONTAINER), AND I DON'T WANT TO SEND THEM A LONG DISTANCE FOR DISPOSAL. CAN I STORE THEM UNTIL A PCB DISPOSAL SITE CLOSE TO ME IS APPROVED?

The mentioned items may be stored until the last day of 1983.

- (51) ONCE PCB ARTICLES ARE TAKEN OUT OF SERVICE, HOW LONG CAN THEY BE KEPT BEFORE BEING PLACED IN AN APPROPRIATE STORAGE AREA? WHAT ABOUT PCB EQUIPMENT CONTAINING LEAKING PCB ARTICLES?

Non-leaking PCB articles and PCB containers containing leaking articles can be temporarily stored for up to 30 days.

- (52) WHEN PCB CAPACITORS OR CONTAINERS ARE STORED IN AN APPROPRIATE STORAGE AREA, WHAT HAPPENS WHEN ONE OF THESE ITEMS STARTS TO LEAK?

A leaking PCB capacitor should be immediately placed in a non-leaking Department of Transportation approved drum and any spillage cleaned up using sorbent or suitable solvents. It is a good practice to add sorbent material, such as saw dust, to the container to soak up any liquid that continues to leak out of the capacitor.

When a container develops a leak, the contents should immediately be transferred to another, non-leaking container or to special "overpack" containers, such as those used in the chemical industry for leaking containers.

- (53) MUST THE EPA INSPECT A PCB STORAGE AREA ONCE IT IS BUILT BEFORE IT CAN BE USED?

No, it is the responsibility of the organization storing the PCBs to insure that the storage area meets the specifications.

- (54) DO PCB STORAGE AREAS HAVE TO BE PERIODICALLY CHECKED FOR LEAKS OR OTHER PROBLEMS? WHAT ABOUT PCB ARTICLES, SUCH AS TRANSFORMERS, THAT ARE IN SERVICE?

PCB storage areas must be checked by the owner or operators at least every 30 days. Articles in service are not required to be checked by the regulations, but periodic checks would be a wise practice.

SPILLS

- (55) DO PCB SPILLS HAVE TO BE REPORTED

Under the authority of TSCA, PCB spills have to be reported whenever the incident poses a substantial risk to human health or the environment. Since "substantial risk" cannot be precisely defined, however, any spill should be reported when people come into direct and uncontrolled contact with PCBs, or the extent of the spill is large enough to expose significant numbers of animals.

In addition, a spill should also be reported when the volume or the extent of the spill is unknown -- such as spills that enter drainage systems. PCB spills into water, onto shorelines, or those that threaten water-courses should always be immediately reported.

EPA is currently completing regulations under the Clean Air Act that will require reporting for water-related hazardous chemical spills (including PCBs). These regulations will have criminal penalties for failing to report such spills.

As a general rule, spills involving a single capacitor do not have to be reported unless PCBs threaten or enter a water-course. Because of the greater threat to health and the environment, transformer spills should be reported -- unless only

minor leaks as bushing leaks, are involved. Any spillage or leaking should be stopped and repaired as soon as possible.

(56) HOW DO I REPORT PCB SPILLS?

PCB spills can be reported to the National Response Center operated by the U.S. Coast Guard at 800-424-8802 (in the District of Columbia, call 426-2675).

(57) WHAT HAPPENS WHEN I REPORT A PCB SPILL? CAN I GET INFORMATION OR ADVICE ON WHAT TO DO ABOUT THE SPILL?

The National Response Center will direct the report to the appropriate EPA environmental emergency office, based on the location of the spill. Experts from these offices (or related state and local experts) will contact persons responsible for the spills, in order to evaluate the potential environmental threat and to determine the appropriate spill control and cleanup measures.

(58) IF I HAVE A SPILL, WHAT SHOULD I DO TO CONTROL OR CLEAN UP THE SPILL?

The first priority is to control the spread of the spill by damming or diking the leak. Also, any threats to water should be given top priority.

Once a spill is contained clean up measures can begin. Clean up can be simply the removal of contaminated soil or debris. In some cases, more complex techniques may be required, such as special PCB sorbents or special filtration/carbon absorption removal of PCBs from water.

Large and complicated spills should be cleaned up by trained and experienced personnel. Organizations, who frequently handle PCBs, should develop contingency plans and conduct training for dealing with spills. Commercial firms are also available on a contract basis to clean up spills. Government spill experts can provide information on such firms.

RECORDKEEPING

(59) MUST COMPANIES KEEP RECORDS OF THE DISPOSITION OF PCBs IN SERVICE? IN STORAGE? IF SO, FOR HOW LONG?

If you own or operate a facility which uses PCBs or PCB items, or have either stored, you are to keep records of their

disposition. Specifically, this applies to facilities using or storing at least 99.4 pounds (45 kilograms) of PCBs in PCB Container(s); one or more PCB Transformers; or 50 or more PCB High or Low Voltage Large Capacitors.

These records shall be maintained for at least 5 years after the facility ceases using or storing PCBs or PCB Items in prescribed quantities.

- (60) DO PCB INCINERATOR FACILITIES HAVE TO KEEP RECORDS? CHEMICAL WASTE LANDFILL FACILITIES? HIGH EFFICIENCY BOILER FACILITIES? IF SO, FOR HOW LONG?

Owners or operators of all three types of PCB Disposal Facilities have to keep records. Incinerator and high efficiency boiler facilities must keep their records for 5 years; chemical waste landfill facilities must keep their records for at least 20 years after PCBs have stopped being disposed there.

- (61) WHEN MUST I BEGIN KEEPING RECORDS OF MY PCB FACILITIES?

PCB recordkeeping, if applicable, was to have begun on July 2, 1978. These records form the basis of an annual document prepared for each facility by July 1; the first annual reports should be compiled by July 2, 1979.

- (62) MUST COMPANIES SEND THEIR ANNUAL REPORTS CONCERNING PCBs TO EPA OR KEEP THEM FOR THEIR OWN RECORDS?

Companies should keep their PCB records and annual reports at their facility for inspection by EPA personnel. Do not send the records or reports to EPA unless it is specifically requested by the Agency.

- (63) I HAVE PCB FACILITIES IN SEVERAL LOCATIONS. DO RECORDS HAVE TO BE KEPT AT EACH SITE?

Owners or operators of more than one facility having PCBs may choose to keep all of the records at a single facility, but the identify of that single facility must be available at each location. The record location must be manned at least 8 hours a day for a normal 40 hour week.

(64) HOW DO I DISPOSE OF TRANSFORMERS CONTAINING PCBs?

There are two ways to dispose of a PCB Transformer, which contains PCB concentrations in excess of 500 ppm. The transformer and the dielectric fluid can be burned together in a high temperature incinerator approved by EPA, or the liquid can be drained out of the transformer first. If the liquid is drained, the transformer must be flushed with solvent for 18 hours; the solvent and the dielectric fluid must then be disposed of in an EPA approved high temperature incinerator. The drained transformer after it is resealed must be disposed of in a chemical landfill which has been approved by EPA.

If the transformer is a PCB-Contaminated Transformer, containing more than 50 ppm PCB and less than 500 ppm PCB, the transformer and the liquid can also be incinerated or the dielectric liquid can first be drained. If the liquid is drained it can be disposed of in a high temperature incinerator, a chemical landfill which has been approved by EPA, or in a high efficiency boiler. The drained transformer can be disposed of as scrap or in a disposal facility equivalent to good municipal solid waste disposal practices.

(65) HOW DO I DISPOSE OF LARGE PCB CAPACITORS?

Until January 1, 1980, large PCB capacitors can be disposed of in EPA approved chemical waste landfills or high temperature incinerators. After January 1, 1980, they must be disposed of by high temperature incinerators. It is expected that hammermill-type crushers will be used at the incinerators to improve the destruction efficiency. These large capacitors account for approximately one-third of the PCBs currently in service.

(66) WHERE CAN PCB ARTICLES (OTHER THAN PCB TRANSFORMERS AND CAPACITORS) BE DISPOSED?

PCB articles can be disposed of in a chemical waste landfill, as well as, in high temperature incinerators, provided they are EPA approved. Examples of these articles, which account for less than 1% of the PCBs currently in use in the U.S., are pipes, hoses, parts of heat transfer systems, electromagnets, and electric motors.

When these articles are disposed of in chemical waste landfills, they must be drained of free flowing liquid, and therefore, will contain only small amounts of PCBs.

- (67) ARE THERE SPECIAL DISPOSAL REQUIREMENTS FOR SMALL PCB CAPACITORS CONTAINED PRIMARILY IN SMALL APPLIANCES AND FLUORESCENT LIGHT BALLASTS?

No, small capacitors can be disposed of as municipal waste. EPA has determined that the random disposal of small capacitors in municipal solid waste sites by householders and other infrequent disposers does not present an environmental hazard.

However, the disposal of large quantities of small PCB capacitors by commercial and industrial activities poses a larger environmental risk. Therefore, EPA encourages these persons to establish voluntarily a collection and disposal program that would result in the waste capacitors going to chemical waste landfills or high temperature incinerators.

- (68) HOW CAN I DISPOSE OF THE DIELECTRIC FLUID IN MY TRANSFORMER?

Fluids from PCB Transformers (concentrations of 500 ppm greater) must be disposed of only by high temperature incineration. Fluids from PCB-Contaminated Transformers (with 50 ppm to 500 ppm PCBs) must be disposed of in high efficiency boilers, in approved chemical waste landfills, or in high temperature incinerators. Fluids from Non-PCB Transformers (with less than 50 ppm PCBs) have one disposal restriction: they cannot be used as a sealant, coating, or dust control agent if they contain any detectable PCB.

- (69) WHERE CAN OTHER LIQUID WASTES WITH OVER 500 PPM PCB BE DISPOSED? BETWEEN 50 AND 500 PPM PCBs? LESS THAN 50 PPM PCBs?

The same disposal options apply as for transformer dielectric fluid.

- (70) WHERE CAN NON-LIQUID PCBs BE DISPOSED?

Non-liquid PCBs at any concentration (e.g., contaminated rags and absorbent materials, and contaminated soils and other solids recovered from spills or removed from old disposal sites) can be disposed in approved chemical waste landfills.

- (71) CAN DECONTAMINATED PCB CONTAINERS BE DISPOSED OF IN AN ORDINARY LANDFILL SITE?

Yes, decontaminated PCB containers may be disposed of in ordinary landfill sites, rather than in EPA approved chemical waste landfills.

(72) CAN DECONTAMINATED PCB CONTAINERS BE REUSED?

Containers decontaminated in accordance with regulations can be reused for general use.

(73) HOW CAN PCB CONTAINERS USED ONLY TO HOLD LOW PCB CONCENTRATIONS BE DISPOSED?

PCB Containers used only to contain materials or fluids, with PCB concentrations between 50 and 500 ppm can be disposed of as municipal waste.

(74) WHAT ARE THE REQUIREMENTS FOR DISPOSAL SITES?

Incinerators used to dispose PCBs must be approved by the appropriate EPA Regional Administrator. The approved incinerators must meet the requirements set out in Annex I of the May 31, 1979 Rule.

Likewise, the chemical waste landfills used for the disposal of PCBs and PCB Items must be approved by the appropriate EPA Regional Administrator, which must meet the requirements established in Annex II of the Final Rule.

"High efficiency boilers used for the disposal of PCB-Contaminated non-mineral oil fluids must also be approved by the appropriate EPA Regional Administrator using the procedures established in paragraph 761.10 (a)(3)(iii)(B) of the Final Rule. High efficiency Boilers used for the disposal of PCB-contaminated mineral oil fluids do not need to be approved, however, persons are required to notify the appropriate Regional Administrator using the procedures established in paragraph 761.10 (a)(2)(iii)(B) before commencing such burning."

(75) HAVE ANY DISPOSAL SITES BEEN APPROVED FOR PCBs? WHERE ARE THEY?

Yes, seven chemical waste landfill sites, and one limited use incinerator, have been approved. No incinerator sites have yet been approved, but three sites are currently being considered.

The landfill locations are as follows:

1. Facility: General Electric Co., Silicone Products Division, Facility Address: 260 Hudson River Rd., Waterford, New York 12189. Facility Telephone Number (518) 237-3330. Type of Facility Approved: Incinerator. Type of PCB Waste Handled: Approval allows G.E. to incinerate only those PCB wastes which are generated on site, i.e., G.E. cannot accept PCBs for incineration from any other company or any other G.E. facility.

2. Facility: Newco Chemical Waste Systems, Inc. Facility Address: 4526 Royal Avenue, Niagara Falls, New York 14330. Facility Telephone Number: (716) 285-6944. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums).
3. Facility: SCA Chemical Services, Inc. Facility Address: 1550 Balmer Rd., Model City, New York 14107. Facility Telephone Number: (716) 754-8231. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums).
4. Facility: Waste Management of Alabama, Inc. Facility Address: P. O. Box 1200 Livingston, Alabama 35470. Facility Telephone Number: (205) 652-9329. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soils, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums).
5. Facility: Casmalia Disposal. Facility Address: 539 Ysidro Rd., P. O. Box 5275, Santa Barbara, California 93108. main office (site located near Casmalia in Santa Barbara County). Facility Telephone Number: (805) 969-4703. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums).
6. Facility: Nuclear Engineering Co., Inc. Facility Address: 9200 Shelbyville Rd., Suite 526, P. O. Box 7246, Louisville, Kentucky 40207; main office (site located near Beatty, NV in Nye County). Facility Telephone Number: (502) 426-7160. Type of Facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, and other debris; Dredge spoils; Municipal sludges; and Properly drained containers (drums).
7. Facility: Chem-Nuclear Systems, Inc. Facility Address: P. O. Box 1269, Portland, Oregon 97205 Main Office (Site located in Arlington, Oregon). Facility Telephone Number: (503) 223-1912. Type of facility Approved: Chemical Waste Landfill. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, asphalt, and other debris; and Properly drained containers (drums).
8. Facility: Wes-Con., Inc. Facility Address: P. O. Box 564. Twin Falls, Idaho 83301. Main Office (Site located in Grand View, Idaho). Facility Telephone Number: (208) 734-7711. Type of Facility Approved: Disposal in Missile Silos. Type of PCB Waste Handled: Capacitors (small and large); Properly drained transformers; Contaminated soil, dirt, rags, asphalt, and other debris; and Properly drained containers (drums).

- (76) CAN A COMMON CARRIER (E.G., TRUCK LINE) TRANSPORT PCBs FOR A COMPANY TO A DISPOSAL FACILITY IF THE TRANSPORT IS NOT WITHIN THE INDUSTRY?

If the common carrier complies with the Hazardous Materials requirements set by the Department of Transportation, and the vehicle is properly and visibly labeled on its exterior with a PCB label it can be used to transport PCBs to a disposal site.

PCBs IN THE WORKPLACE

- (77) ARE THERE ANY OSHA RULES GOVERNING PCBs IN THE WORKPLACE?

Yes, there are OSHA regulations governing PCBs in the workplace. In 1977 the National Institute of Occupational Safety and Health (NIOSH) -- the HEW organization responsible for researching workplace safety -- published "Criteria for a Recommended Standard ... Occupational Exposure to Polychlorinated Biphenyls (PCBs)". OSHA, associated with the Department of Labor, will use this document to develop mandatory standards regarding PCBs. However, OSHA Act requires employers to provide employees with a place of employment that is free from recognized hazards.

- (78) WHAT IS A RECOMMENDED STANDARD FOR OCCUPATIONAL EXPOSURE?
WHAT IS THE STANDARD RECOMMENDED BY NIOSH FOR OCCUPATIONAL EXPOSURE TO PCBs?

A recommended standard is a determination of the level of exposure that will substantially reduce any risks of reproductive or tumorigenic effects of PCBs and prevent other adverse effects of exposure in the workplace. It is based on a 10-hour workday, 40-hour workweek, over a normal working lifetime.

NIOSH has recommended in their Criteria Document for PCBs that occupational exposure to PCBs be controlled so that no worker is exposed at a concentration greater than 1.0 microgram total PCBs per cubic meter of air (1.0 Mg/cu m), determination as time-weighted average (TWA) concentration, for up to a 10-hour workday, 40-hour workweek. This is only a recommended standard and it has not been adopted to date, by either OSHA or EPA. At the present time, however, OSHA is reviewing this recommended standard.

- (79) DID NIOSH RECOMMEND ANYTHING ELSE TO REDUCE EXPOSURE TO PCBs IN THE WORKPLACE?

Yes, NIOSH made recommendations about work practices, personal protective equipment and clothing, medical surveillance, personal clean up and sanitation practices, and employee information programs.

(80) HOW DO OSHA STANDARDS AND NIOSH RECOMMENDATIONS RELATE TO EPA's PCB REGULATIONS?

EPA's PCB Rules do not directly regulate workers, but the Rules do restrict or prohibit certain PCB activities which reduce the number of workers exposed. The EPA Rules prohibit PCB transformer and capacitor manufacture, as well as PCB transformer rebuilding (except for railroad transformers); these activities were the major long-term occupational exposures to high concentration PCBs.

Worker exposure can also occur as a result of PCB spills and authorized servicing operations for PCB transformers.

(81) WHAT KIND OF PROTECTIVE CLOTHING SHOULD BE WORN WHEN WORKING WITH PCBs?

The type of protective clothing which should be worn when working with PCBs is dependent on the individual circumstances. Worker protective clothing and equipment is intended to prevent skin and eye contact, and control respiratory exposure.

Respiratory exposure control (whether individual protection or workplace control) is most relevant for long-term production operations or major spills. PCB Transformer spills pose respiratory problems because of solvents, such as trichlorobenzene, that are mixed with the PCBs. Small spills, such as capacitor failures, seldom pose respiratory problems, but protection should be provided for incidents in confined areas.

Skin protection can usually be achieved by wearing non-porous gloves and boots and heavy overalls. For major spill clean up activities, a full suit of non-porous clothing may be appropriate. Also, non-porous aprons can be effective in reducing contamination of worker clothing. Non-porous protective gear can usually be laundered and reused, unless the garment is heavily contaminated. It is wise to launder work clothes separately from other garments.

Eye protection should be worn when it is possible for PCBs to be splashed in the eyes. Removing contaminated soil does not usually pose such a threat.

(82) IF I GET PCB LIQUID ON MY SKIN, HOW CAN I REMOVE IT?

If liquid or solid PCBs are splashed or spilled on an employee, contaminated clothing should be removed promptly and the skin washed thoroughly with soap and water for at least 15 minutes.

Eyes should be irrigated for at least 15 minutes if liquid or solid PCBs get into them. A drop of vegetable oil may be put into the eye to relieve the irritating effect of PCBs.

Nevada Power Specifics and Program

(83) WHERE DOES NEVADA POWER DISPOSE OF ITS PCB WASTES?

Nevada Power Company's PCB waste is disposed of at an approved chemical waste landfill near Beatty, Nevada (N.E.C.C.O.).

(84) HOW MANY PCB CAPACITOR BANKS DOES NEVADA POWER HAVE?

Nevada Power has 611 PCB capacitor banks located on poles, and in Substations.

(85) HOW MANY TRANSFORMERS CONTAINING PCB FLUIDS ARE ON YOUR SYSTEM?

We have seven indoor transformers, containing PCB fluid, located at various hotels, shopping centers, and government buildings. We also have fifteen indoor transformers located at our power generating stations.

(86) HOW MUCH PCB FLUID IS CONTAINED IN EACH CAPACITOR UNIT?

Depending on the size, approximately 1 to 2 gallons of PCB fluid is contained in each capacitor unit.

(87) WHAT IS NEVADA POWER COMPANY'S PCB POLICY?

Nevada Power Company is committed to a balance of conservation and utilization of our natural resources and to ensure an adequate energy supply to the customers within our service area. Our environmental policies recognize that to achieve this goal our facilities and operations must be conducted and operated within environmental requirements. The Toxic Substance Control Act is one of such federal regulations which prescribes the requirements for the collecting, handling, transportation, and disposal of Polychlorinated Biphenyls or PCB's.

The policies and implementing procedures of this program are mandatory for use by all affected Nevada Power Company personnel.

(88) HOW MUCH OF A PROBLEM IS EXPOSURE OF PCBs TO THE PUBLIC, AND WHAT ARE YOU DOING TO INFORM OR EDUCATE?

1. We have 629 pole, substation, and customer vault locations containing PCB fluid. All locations have been identified by a 6" required label as per the EPA regulations. At pole locations the label (sign) is located approximately 8' from the ground.

2. Several months before the regulations went into effect, we started purchasing and installing non-PCB capacitor banks. We have eight such locations.

Nevada Power Specifics and Program

3. We have conducted training programs with Area fire departments and with all of our affected personell in control and handling procedures. This program is also offered to interested groups or organizations.

Exposure to the public

4. We have undertaken a program to reduce the exposure to the public from coming in contact with unintentional spills by re-locating several of our outdoor pole capacitor locations to areas of less pedestrian access away from bus stops, swimming pools, playgrounds, and school yards.

5. In our UGR vault locations with sump pumps that have transformers containing PCB fluids we have installed PCB absorptive pillows and bales in the pump pits to collect any spill that may occur. Other indoor transformer locations have dikes or metal trays under them.

6. A large number of our capacitor banks are located remote from general public access such as in locked substations, in the desert and rural areas.

7. A number of capacitor banks are out of service (45) due to maintenance that has to be performed, also the use of the capacitors is mostly seasonal and conservatively 25% may be out of service at any given time.

(89) WHAT DO I DO IF A SPILL OCCURS ON MY PROPERTY AND HOW DO I HANDLE IT?

1. If a spill occurs on your property call Nevada Power Company on the emergency phone number. If there should be a fire at or near the top of the pole, call the Fire Department also.

2. Stay well away from the spill area. Do not walk on the spilled liquid, or get any of the fluid (it is oily) on your body or clothing, and keep pets away also, until our crews undertake the cleanup operation.

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United States
Environmental Protection
Agency
Washington DC 20460 TS 799
Official Business
Penalty for Private Use \$300

First-Class Mail
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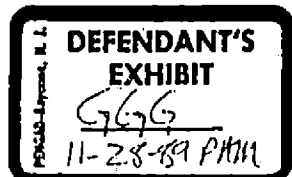
Toxic Substances



Polychlorinated Biphenyls:

An Alert for Food and Feed Facilities

PROP



Important Notice: PCB Incinerators

At the time this booklet went to press, there were still no approved PCB incinerators or alternative disposal methods available for commercial use in the United States. *Until incinerators or alternative disposal methods are available, it is not advisable to remove PCB fluids or intact PCB-containing equipment unless safe storage facilities are available off the site.*

EPA permits disposal of large PCB capacitors in approved chemical waste landfills until March 1, 1981. EPA requires all PCB capacitors to be containerized and packed with absorbent material prior to their disposal in chemical waste landfills.

Several food contamination incidents have been caused by PCBs in storage. These incidents indicate that removing PCB equipment or draining fluid from a PCB transformer and storing the equipment or fluid may result in an increased risk of contamination. Therefore, instead of removing this equipment from service at this time, carefully examine the risk of leaks or spillage and monitor continued operations closely. (See suggestions in paragraph C of checklist.) If there is potential for leaks or spills, corrective measures must be taken, including removal of equipment and fluid to a safe storage area away from the premises. If you have any questions, consult with your regional EPA or FDA office or local USDA inspector.

At the present time, we anticipate that the first incinerator will be available in late 1980. EPA will publicize information on commercial PCB incinerators as soon as they are approved. In addition, you may check on the availability of incinerators or alternative disposal methods by either calling EPA's Office of Industry Assistance toll-free (800) 424-9065 or calling your regional EPA or FDA contact or local USDA inspector. (See list of names and numbers in the booklet.)

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N. 06688.

December 1979

FOREWORD



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON DC 20460

December 1979

OFFICE OF TOXIC SUBSTANCES

The food and feed industries are particularly vulnerable to contamination from polychlorinated biphenyls (PCB). PCBs are ubiquitous, persistent industrial chemicals that are known to cause serious health and environmental effects. The Environmental Protection Agency has responsibility for regulatory control of PCBs and other toxic substances under the Toxic Substances Control Act of 1976. We are working cooperatively with the Food and Drug Administration, which regulates chemical substances in food and their use in food and animal feed plants, and the Department of Agriculture, which has responsibility for assuring the safety of meat and poultry, to protect our food supply from PCB contamination.

This booklet has been prepared to:

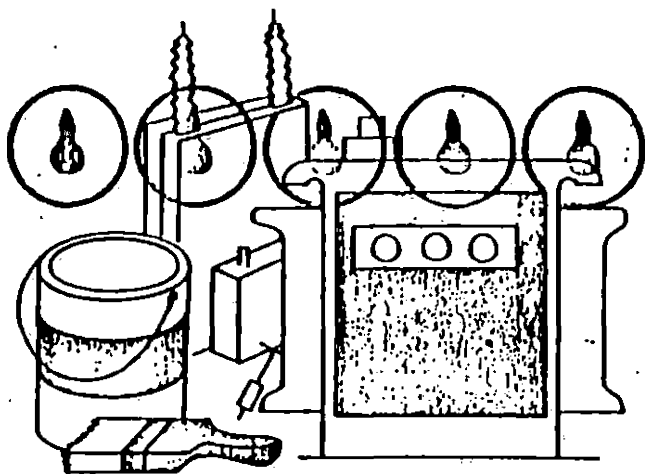
- Alert you to the serious potential problems associated with the use of PCB-containing equipment in the food and feed industry,
- Provide information that will help you establish a program for contamination prevention in these facilities, and
- Provide information on current PCB government regulations and a reference of sources of additional information.

PCB contamination has already caused costly destruction of large quantities of food and uncountable damage to our environment. We urge you to alert your managers and employees to the problem of PCB contamination and to institute a program for preventative action without delay. This brochure will assist you in your efforts.


Steven D. Jellinek

Why the concern?

In recent years, there have been a number of incidents where food has been contaminated with polychlorinated biphenyls (PCBs) and other toxic chemicals. This contamination has resulted from accidental spills, improper disposal, and unintentional misuse of PCB-containing materials and equipment. PCBs are now known to have extremely hazardous health and environmental effects, even at low levels of concentration in the food chain. PCB-containing equipment, such as electrical transformers, has been extensively used in food and feed processing facilities. We are especially concerned that future accidental contamination be prevented. This booklet has been prepared to help you identify potential problems and prevent costly future incidents that could have adverse effects on health and the environment.



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What are PCBs — why, how, and where are they used?

PCBs are a class of chemicals called chlorinated hydrocarbons. PCBs range in consistency from heavy oily liquids to waxy solids. Their most important properties are chemical stability, low flammability, high boiling points, and low electrical conductivity.

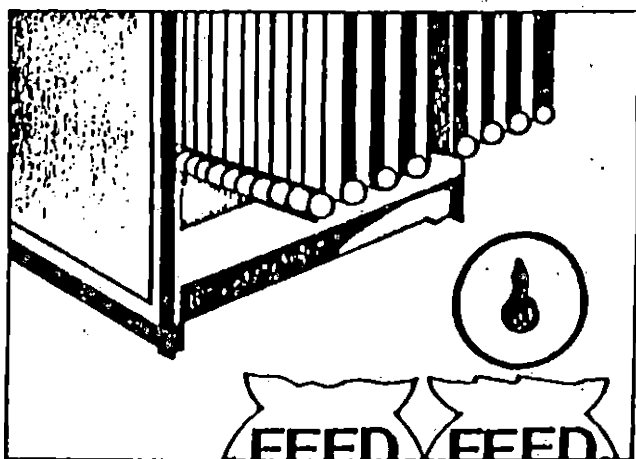
Since their development in 1929, PCBs have been used in a variety of industrial applications. Hundreds of

PCBs have also been used as plasticizers in paints, adhesives, and caulking compounds; fillers for investment casting waxes; and dye carriers in carbonless copy paper.

Concern over PCBs' toxicity and persistence in the environment led Congress to prohibit their manufacture, processing, or distribution in commerce. Although PCBs have not been manufactured in the United States since 1977, the chemical has been permitted to remain in older electrical transformers and other industrial machinery.

Why are PCBs hazardous?

Knowledge of PCB toxicity in humans is based primarily on an incident which occurred in Yusho, Japan in 1968 when PCBs leaked from a heat exchanger and contaminated rice oil. Among the many symptoms observed were chloracne (skin rash), discoloration of the gums and nailbeds, swelling of joints, waxy secretions of glands in the eye lids, as well as more general effects such as lethargy and joint pain. There are also well documented tests on laboratory animals that show PCBs cause reproductive failures, gastric disorders, skin lesions, tumors, and other effects of concern.

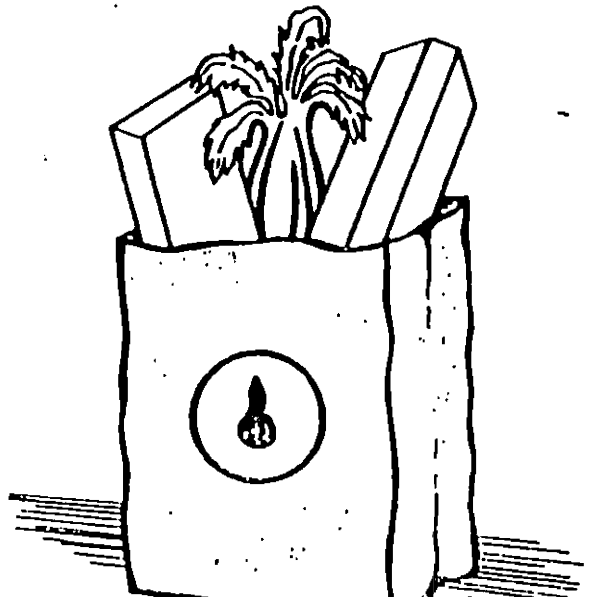


Why should food and feed related industries be especially concerned about PCBs?

The Yusho Incident illustrates the serious human health and economic consequences of PCB contamination in food or feed related industries. Several other incidents underline the need for special attention to prevent similar costly contamination in the future. These include:

- Discovery of PCBs in fishmeal used as a feed ingredient in North Carolina as a result of a leaking heat exchanger,
- Contamination of fishmeal in Puerto Rico resulting from a fire involving stored electrical transformers in the same warehouse,
- Death and severe illness of feedlot cattle in Kansas caused by inadvertent use of PCB-contaminated oil as a carrier for insecticide,
- Contamination of animal feed ingredients with PCBs leaking from a transformer in storage at a packing company in Billings, Montana.

These incidents have resulted in the destruction of large quantities of food, feed, and farm animals, and major disruption of the companies involved.



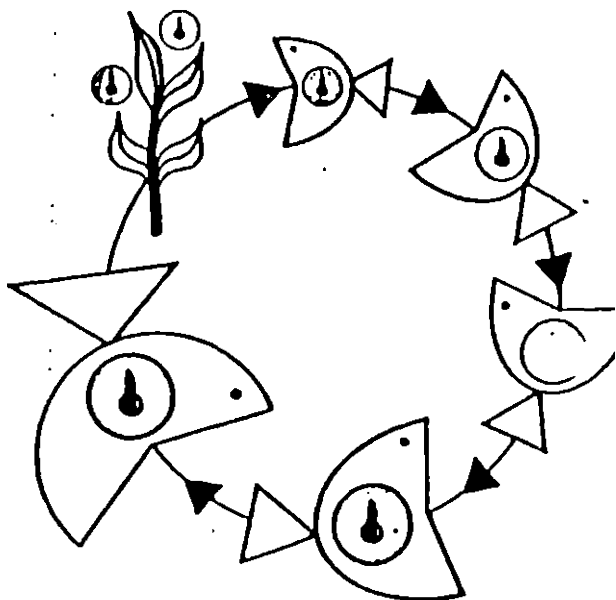
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PCBs in the environment

Unlike most organic chemicals which break down fairly rapidly in the environment, PCBs are extremely stable. The potential for biomagnification in the food chain is of special concern. Biomagnification is the process through which small amounts of toxic substances reach higher levels of concentration at each stage of the food chain.

Microorganisms and plants take in traces of PCBs from the environment. These microorganisms and plants provide the food for small fish and other animals. These are in turn eaten by higher forms of animal life. At each step of the sequence, the PCB content increases until human food supplies may be contaminated above the levels considered to be safe for consumption.



Where might PCBs be found in food industry facilities?

The following types of equipment may contain PCB fluids or other liquids such as mineral oil that are contaminated with PCBs:

- *Transformers*
- *Large capacitors (over 3 lbs. of fluid)*
- *Electromagnets*
- *Heat transfer and hydraulic systems*
- *Small capacitors*
- *Equipment containing small capacitors including: electrical switch gear, fractional HP motors, and ballasted lighting fixtures.*

Transformers, large capacitors, electromagnets, and heat transfer and hydraulic systems are of primary importance because they contain free flowing liquid. Small capacitors are of less concern because the PCBs are usually in a nonliquid, nonmobile state.



ELECTROMAGNETS
Electromagnets containing PCBs have been used as separator magnets over conveyor belts.



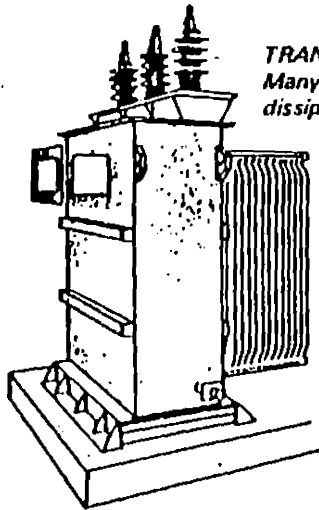
CAPACITORS

Capacitors have been manufactured in a wide range of sizes for various industrial uses. Capacitors may contain PCB dielectric fluids.



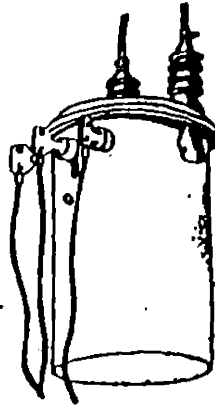
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TRANSFORMERS

Many transformers have used PCB liquids to dissipate the heat generated by transmission.



HEAT TRANSFER SYSTEM

Heat transfer systems containing PCBs have been used in food processing equipment.

Existing federal regulations concerning PCBs and food

Concern about highly toxic PCBs contaminating food has led to a number of regulatory actions by the Food and Drug Administration (FDA), the U.S. Department of Agriculture (USDA), and the Environmental Protection Agency (EPA). Under FDA regulations foods and feeds are considered to be contaminated and may not be sold in interstate commerce if they contain PCBs in excess of certain prescribed concentrations. (See Table 1.) The use of PCBs in food and animal food processing facilities, except enclosed use in transformers and capacitors, is prohibited by FDA regulation (21 CFR 110.40, 500.45).

EPA has issued rules governing the use of PCBs. In general, PCB mixtures with concentrations less than 60 parts per million (ppm) or 0.005 percent are not regulated. The use of intact, non-leaking transformers, electromagnets, capacitors, and capacitor-containing

The EPA rule permits the continued use of PCBs in servicing of electromagnets and transformers and in heat transfer and hydraulic systems until July 1, 1984. As of November 1, 1979, PCBs may no longer be used in heat transfer systems in plants manufacturing or processing food, drugs, and cosmetics.

EPA rules include provisions for marking, disposal, storage, and recordkeeping, portions of which are discussed later in this booklet.

The potential for further regulatory action exists. On May 9, 1980, EPA, FDA, and USDA proposed to prohibit the use of PCB transformers, capacitors, and other electrical equipment in food, feed, and agricultural chemical related facilities. For copies of the proposal, contact the Industry Assistance Office.

The following checklist for Action has been prepared to assist you in conducting a full safety check of your facility. We urge you to use this checklist to implement a program for safety and contamination prevention in all your food and feed related facilities.

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Checklist for Action What can I do?

A. Determine if you have PCB equipment.

1. Locate any potential PCB source.

You should inventory your plant for transformers, capacitors, heat transfer systems, hydraulic systems, and fluid stored for use in this equipment. After you have located these items, . . .

2. Examine the equipment for caution labels.

A caution label specifically identifying the equipment as containing PCBs may be present. If so, skip to Section B of this checklist. If not, . . .

3. Transformers and large capacitors may bear nameplates.

If your transformer or capacitor has a manufacturer's nameplate with a trade name, refer to Table 2 at the end of this booklet. If the trade name does not appear there, the equipment may still contain PCBs. Contact the manufacturer, referencing the serial number to determine if the equipment contains PCBs. If there is no nameplate, or if this approach is unsuccessful . . .

4. Seek assistance from a servicing expert.

Call on your local transformer servicing company or the engineering service department of your utility com. They can assist you to obtain a sample of your transformer fluid for analysis. You may also want to sample your heat transfer systems, hydraulic systems, or other suspect oil. (Do not attempt to sample fluids in capacitors.) Then . . .

5. Have the samples analyzed.

This is the only way to be certain whether or not your equipment contains PCBs.

If you determine that you have PCB equipment, . . .

B. Consider replacing PCB-containing equipment with non-PCB equipment.

EPA, FDA, and USDA have proposed to prohibit the use of PCBs in electrical equipment in food, feed, and agricultural chemical related industries. Although the prohibition on PCB-containing equipment is not yet in effect, we urge voluntary removal

As an alternative in transformers, you may want to consider replacing the PCB fluid with non-PCB fluid. You should be aware that the transformers will contain residual PCB concentrations after replacement and, therefore, may be subject to future federal regulation.

EPA disposal regulations require incineration of all PCB liquids with concentrations of 500 ppm (0.05%) or greater. The first approved incinerators will be available sometime in late 1980. Until incinerator methods are available, PCBs removed from service must be stored for later disposal.

If it is not possible for you to replace your PCB-containing equipment, you will want to . . .

Take special precautions for continued use.

The risk of PCB contamination can be minimized by analyzing the risk of spillage associated with each individual PCB unit and by taking steps to contain the potential uncontrolled loss of PCBs from the unit. You should consider the following questions:

1. Is there any evidence of an active leak from the PCB unit? If so, take whatever steps are necessary to protect your product or usable byproduct. Of course, leaking equipment should be repaired immediately. If your product is being contaminated, contact the appropriate agency to determine the best way to destroy it.
2. Is the PCB unit located in an area where there is a way that leaking fluid from the unit could find its way into your process? If so, these units should be given priority in the development of spill prevention measures. Special consideration should be given to potential leaks resulting from accidents as discussed in the following.
3. Is any liquid ever pumped from the vicinity of the PCB unit to the process area? If so, can the PCB unit be isolated from the pump?
4. If the PCB unit is pad mounted, are there curbs or pans to serve as a barricade against loss of fluid?
5. If the PCB unit is located in an area surrounded by porous cinderblock walls, have they been sealed with material which will not dissolve in solvents such as PCB and trichlorobenzene? Is the wall/floor interface

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6. Is the floor in the vicinity of a PCB unit free from cracks? Cracks that look like they would not prevent the loss of fluid should be grouted and painted with solvent resistant materials, or government approved materials if required.

7. Is the PCB unit in a location where vehicular traffic might be a hazard? If so, a vehicle barrier might be useful.

8. Is the PCB unit located near machinery which might throw projectiles with sufficient energy to damage the unit? If so, a shield, such as a fence, may provide the necessary protection.

9. Is the PCB unit mounted on a surface which might be difficult to seal, such as unwelded steel plates or in a mobile machine? If so, a catchbasin might be installed under the unit.

10. Are there floor drains in the vicinity of a PCB unit? If so, can they be sealed or otherwise isolated from the unit?

11. If you have PCB equipment or drums of PCB fluid in storage for future use, can they be removed from the process area? Are they marked or labeled to warn of PCB presence? If you have PCB equipment, you may be subject to mandatory labeling and storage requirements.

D. Be familiar with mandatory labeling and storage requirements.

1. Labeling requirements.

The EPA label for PCBs looks like this.



You must label the following items: transformers containing liquids with more than 500 ppm of PCBs, PCB capacitors with 3 (three) or more pounds of fluid operating at 2,000 volts or more, containers such as bags, barrels, or drums used to hold PCBs, electric motors using coolant with 50 ppm or more of PCBs, hydraulic systems or heat transfer systems containing 50 ppm or more of PCBs, and the storage areas described in the following.

In addition, labels must be placed on the following items when they are removed from service: PCB capacitors containing more than 3 pounds of fluid operating at less than 2,000 volts and equipment containing a PCB transformer or large high voltage capacitor.

2. Storage requirements.

PCBs and PCB items which you remove from service for disposal must be stored in a location meeting EPA criteria to insure that they are properly contained. This location should not be near your process area. It should be isolated so that it is not vulnerable to damage and puncture from vehicular, forklift, and other moving equipment. For assistance with the storage design criteria, contact the EPA regional office for your state. A list of EPA regional offices appears at the back of this booklet. (See Appendix B.)

E. Obtain further information.

If you do not yet have the EPA regulations on PCBs, you can obtain a free copy from EPA by calling toll free (800) 424-9065 (in Washington, DC, 554-1404) and asking for a reprint of the PCB Ban Regulation, *Federal Register*, May 31, 1979, and for a list of the approved PCB Disposal Facilities.

If you want more background information on the regulation, ask for a free copy of the EPA Support Document to the PCB Ban Regulation at the same phone number. The mailing address is: Industry Assistance Office (IS-799), Office of Toxic Substances, U.S. Environmental Protection Agency, 401 M Street, S.W., Washington, DC 20460. You may also contact the nearest EPA Regional Office. (See Appendix B.)

Other useful background information on PCBs is listed in Appendix A.

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Table 1.

FDA Limits on PCB Concentration in Food

Food	Concentration (parts per million)
Milk and manufactured dairy products	1.5 ppm (fat basis)
Poultry	3 ppm (fat basis)
Red meat	3 ppm (action level) (fat basis)
Eggs	0.3 ppm
Fish and shellfish	5 ppm (edible portion)*
Feed for food producing animals	0.2 ppm (except concentrates, supplements, and premix)
Infant and junior foods	0.2 ppm
Animal feed components of animal origin	2.0 ppm
Paper food packaging in direct contact with food	10 ppm (action level)

Source: Title 21, Code of Federal Regulations, Section 109. Federal Register, Vol. 44, No. 127, June 29, 1979, pp. 38330-38340.

*A regulation establishing a new level of 2 ppm was promulgated but was stayed on October 5, 1979 until further notice.

Table 2.
PCB Manufacturers and Trade Names

PCBs have been marketed and used by manufacturers in their products under various trade names. This list is not necessarily complete since many companies have gone out of business and information is no longer available.

Manufacturer	Country	Trade Name	Manufacturer	Country	Trade Name
Aerovox	US	Hyvol	Monsanto	US	Therminol ^a
Allis-Chalmers	US	Chlorextol	Monsanto	US	Pydraul ^{a,b}
American Corp.	US	Asbestol	Monsanto	US	Santovac 1 and 2
Axel Electronics	—		Niagara Transformer Corp.	US	Askarel ^a , EEC-18
Bayer	Germany	Clophen	P. R. Mallory & Co.	US	Aroclor B
Callaro	Italy	Dk	Power Zone Transformer	US	EEC-18
Callaro	Italy	Fonclor	Prodelec	France	Phenoclor
Callaro	Italy	Inclor	Prodelec	France	Phyralene
Capacitor Specialists	US		R. C. Uptegraff	US	
Chemko	Czechoslovakia		R. F. Interonics	US	
Cornell Dubiller	US	Dykanol	Reliance Electric Co.	US	
Dings Co.	US		Research-Cottrell	US	Askarel ^a
Electrical Utilities Corp.	US	Eucarel	Sangamo Electric	US	Diactor
Electro Engineering Works	US		Sovol	USSR	
Electromagnetic Filter Co.	US		Sprague Electric Co.	US	Chlorinol
Envirotech Buell	US		Standard Transformer Corp.	US	
Eriez Magnets	US	Pyranol	Stens Magnetics	US	
ESCO Mfg. Co.	US	Askarel ^a	Tobe Deutschmann Labs.	US	
Ferranti-Packard Ltd.	US	Askarel ^a	Universal Mfg. Corp.	US	Askarel ^a
General Electric	US	Pyranol	Van Tran Electric	US	
Genava Industries	US		Wagner Electric	US	No-Flamol
H. K. Porter	US		Westinghouse Electric	US	Inerteen
Helena Corp.	US		York Electronics	US	
Hevi-Duty Electric	—	Askarel ^a	—	US	Napolin
ITE Circuit Breaker	US	Non-Flammable Liquid	—	—	Apirolio
Jard Corp.	US	Clorphen	—	—	Kanecolor
Kanegafuchi	Japan	Kennechlor			
Kuhlman Electric	US	Saf-T-Kuhl			
McGraw Edison	US	Elamex			
Maloney Electric	US				
Monsanto	UK and US	Aroclor			
Monsanto	UK and Japan	Santotherm FR			
Monsanto	UK and Europe	Pyroclor			

^aAskarel is the generic name used for nonflammable insulating liquid in transformers and capacitors.

^{b,b}Various products used as heat transfer fluids, such as Therminol FR-O, were manufactured under this name.

^{c,c}Various products used as hydraulic fluid, such as Pydraul A-200, were manufactured under this name.

Appendix A**Other Available Information on PCBs**

This booklet does not go into detail about the health and environmental effects of PCBs or the chemicals now being used as substitutes for PCBs. The following reports cover these technical areas. The NIOSH Criteria Document is particularly recommended for its discussion of health issues for servicing PCB equipment or cleaning up PCB spills.

"Criteria for a Recommended Standard . . . Occupational Exposure to Polychlorinated Biphenyls (PCBs)." DHEW (NIOSH) Publication No. 77-225, September 1977. Order from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price \$4.00 plus postage.

"Assessment of the Use of Selected Replacement Fluids for PCBs in Electrical Equipment." Report No. EPA 560/6-77-008, March 1979. Order from National Technical Information Service, Springfield, Virginia 22161. Report No. NTIS-PB-296 377.

"Polychlorinated Biphenyls and the Environment." 1972. Order from National Technical Information Service, Springfield, Virginia 22161. Report No. NTIS COM-72-10419. This is a thorough discussion of the properties and uses of PCBs.

"PCBs in the United States: Industrial Use and Environment Distribution." 1976. Order from National Technical Information Service, Springfield, Virginia 22161. Report No. NTIS PC 252-012.

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Appendix B

Where Can I Seek Assistance?

Assistance from EPA or FDA may be obtained by contacting your nearest regional office. Plants regulated by the Food Quality Service of USDA may obtain help from their local inspector. The following table lists by the state the ten Federal regional offices for FDA and EPA.

REGION I: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont

EPA	FDA
Mr. Robert Dangel	Mr. A. J. Beebe
Toxic Substances Coordinator	Regional Director
John F. Kennedy Federal Building	585 Commercial Street
Boston, MA 02203	Boston, MA 02109
(617) 223-0585	(617) 223-1278

REGION II: New Jersey, New York, Virgin Islands, Puerto Rico

EPA	FDA
Mr. Ralph Larsen	Mr. Caesar A. Roy
PCB Coordinator	Regional Director
26 Federal Plaza	830 3rd Avenue
New York, NY 10007	Brooklyn, NY 11232
(212) 264-1925	(212) 965-5416

REGION III: Delaware, Maryland, Pennsylvania, Virginia, West Virginia, District of Columbia

EPA	FDA
Mr. Charles Sapp	Mr. R. J. Davis
Toxic Substances Coordinator	Regional Director
Curtis Building (3AH20)	2nd and Chestnut
6th & Walnut Street	Room 900
Philadelphia, PA 19106	Philadelphia, PA 19108
(215) 597-4058	(215) 597-4390

REGION IV: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee

EPA	FDA
Mr. Ralph Jennings	Mr. M. D. Kinslow
Toxic Substances Coordinator	Regional Director
345 Courtland Street, NE	880 W. Peachtree Street
Atlanta, GA 30308	Atlanta, GA 30309
(404) 881-3864	(404) 881-4266

REGION V: Indiana, Illinois, Michigan, Minnesota, Ohio, Wisconsin

EPA	FDA
Mr. Karl Bremer	Mr. L. R. Claiborne
Toxic Substances Coordinator	Regional Director
230 South Dearborn Street, Room 1165	175 W. Jackson Boulevard

REGION VI: Arkansas, Louisiana, New Mexico, Oklahoma, Texas**EPA**

Mr. John West
PCB Coordinator
First International Building
1201 Elm Street
Dallas, TX 75270
(214) 767-2734

FDA

Mr. P. B. White
Regional Director
3032 Bryan Street
Dallas, TX 75204
(214) 749-2735

REGION VII: Iowa, Kansas, Missouri, Nebraska**EPA**

Mr. Wolfgang Brandner
Toxic Substances Coordinator
324 East 11 Street
Kansas City, MO 64106
(816) 374-6538

FDA

Mr. Clifford G. Shane
109 Cherry Street
Kansas City, MO 64106
(816) 374-5646

REGION VIII: Colorado, Montana, North Dakota, South Dakota, Utah, Wyoming**EPA**

Mr. Dean Gillam
Toxic Substances Coordinator
1860 Lincoln Street
Denver, CO 80295
(303) 837-3926

FDA

Mr. F. L. Lofsvold
Regional Director
721 19th Street
US Customhouse Room 500
Denver, CO 80202
(303) 837-4915

REGION IX: Arizona, California, Hawaii, Nevada, American Samoa, Guam, Trust Territories of the Pacific, Wake Island**EPA**

Mr. Gerald Gavin
PCB Coordinator
215 Fremont Street
San Francisco, CA 94105
(415) 556-4606

FDA

Mr. I. B. Berch
Regional Director
UN Plaza
Federal Office Bldg.
Room 526
San Francisco, CA 94102
(415) 556-2062

REGION X: Alaska, Idaho, Oregon, Washington**EPA**

Dr. Jim Everts
Toxic Substances Coordinator
1200 6th Avenue
Seattle, WA 98101
(206) 442-6560

FDA

Mr. J. W. Swanson
Regional Director
909 1st Avenue
Room 6003
Seattle, WA 98174

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**CHEMICAL WASTE LANDFILLS APPROVED
FOR PCB DISPOSAL**

FACILITY NO	SITE LOCATION	FACILITY	FACILITY ADDRESS	EPA REG CONTACT	CAPACITIES (LANDFILL & SMALL CONTAINERS)	PORTABLE GRAINED MATERIALS	CONTAMINATED SOIL, DIRT, RAGS & OTHER DEBRIS	MUNICIPAL SOLIDS	ASPHALT (CONTAMINATED)	LIQUID PCB AT A CONCENTRATION BETWEEN 50 & 500 ppm
2	ALABAMA	WASTE MGMT OF ALABAMA (205) 532-3531 TOLL FREE NO 800 361-7829	P O BOX 1200 LIVINGSTON AL 35470	MR JAMES SCARBROUGH 14041 881-3016	X	X	X	X	X	X
5	CALIFORNIA	CASIMALLA DISPOSAL (805) 949-2897	539 YSIDRO ROAD P O BOX 8275 SANTA BARBARA CA 93106	RAYMOND SEID 14151 556-3450	X	X	X	X	X	X
3	GRAND VIEW ISLAND	WES CON INC (208) 844-2275	P O BOX 564 TWIN FALLS ID 83201	ROGER PUENTES (208) 442-2850	X	X	X	X	X	X
6	BEATTY, NY	NUCLEAR ENGINEERING CO INC (502) 428-7150	3200 SHELBYVILLE RD SUITE 528 P O BOX 7746 LOUISVILLE KY 40207	RAYMOND SEID 14181 556-3450	X	X	X	X	X	X
1	NEW YORK	CECOS INTERNATIONAL (718) 721-2281	4528 ROYAL AVE NIAGARA FALLS NY 14303	WAYNE PIERRE (212) 264-0505	X	X	X	X	X	X
2	NEW YORK	SCA CHEMICAL SERV INC (718) 754-8231	1550 BALMER ROAD MODEL CITY NY 14107	WAYNE PIERRE (212) 264-0505	X	X	X	X	X	X
4	OHIO	CECOS INTERNATIONAL (613) 724-6114	5083 ABER RD WILLIAMSBURG OH 46176	JAY GOLDSTIN (212) 353-2197	X	X	X	X	X	X
7	OREGON	CHEM. NUCLEAR SYS INC (503) 221-2211	P O BOX 1259 PORTLAND OR 97206	ROGER PUENTES (208) 442-2850	X	X	X	X	X	X

Tainted Valentine candy sent to market

ST. LOUIS (AP) — About 45,000 cases of Valentine's Day candy in heart-shaped boxes will go on the market although some of the boxes contain the toxic chemical PCB at 10 times the level allowed by federal guidelines, the St. Louis Post-Dispatch reported in Sunday editions.

In a copyright story, the newspaper said polychlorinated biphenyl was found in boxes containing candy manufactured by E.J. Brach and Sons Inc. of Chicago.

Tests in Boston also showed PCB levels in 1,400 Schrafft's Candy Co. boxes exceeded guidelines for food packaging, the newspaper said.

PCB, a toxic chemical, was banned by Congress for

most purposes effective last January.

The Chicago branch of the federal Food and Drug Administration had recommended its Bureau of Foods seize the Brach's candy boxes. But the bureau refused, saying Valentine candy is a seasonal product with limited consumption, the Post-Dispatch reported.

"To this day, I do not understand why the decision was made," Chicago FDA Director William R. Clark was quoted as saying. "I've spent a couple of sleepless nights since that decision was made."

The Post-Dispatch quoted documents and inspection reports on tests by Chicago inspectors in July and

August that found some PCB levels in the cardboard of Brach's boxes exceeding by 10 times the limits recommended under federal guidelines.

The newspaper quoted Ned Mitchell, the president of Brach's, as saying the candy in question will never reach the public. But FDA officials said the packed candy already has been scheduled for shipment, the Post-Dispatch said.

Thomas Haney, a lawyer for Schrafft's, said 100 tests of boxes showed PCB levels within federal guidelines.

The FDA began an investigation of the candy boxes after an Atlanta couple complained earlier this year of

diarrhea and indigestion after eating several pieces of Brach's Valentine chocolates, the newspaper said.

Mitchell is quoted by the Post-Dispatch as saying Brach had spent about \$150,000 for tests on the boxes.

Officials of the box manufacturer, A. Klein and Co. Inc. of New York, were unavailable for comment. The company's president, Jesse Salmen, was quoted in a recent industry trade journal as saying new test procedures are leading to a marked reduction of box materials contaminated by PCB, the article said.

The FDA guideline on PCB allows 10 parts per million in food packaging.

Las Vegas **REVIEW-JOURNAL**

NEVADA'S LARGEST AND MOST COMPLETE NEWSPAPER

LAS VEGAS, NEVADA, SUNDAY, DECEMBER 30, 1979

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persons.

Truckee water tested for PCB

CARSON CITY (AP) — A jet engine parts firm in Verdi, under investigation for possible chemical PCB pollution, apparently used machining oil with a PCB level higher than the amount allowed by a 10-year-old federal law, state officials said Friday.

Ernie Gregory, chief of the state Environmental Protection Division, said he hopes to have preliminary test results back by early next week — possibly Monday — in efforts to determine whether the pollution at Viking Metallurgical Inc. got into the Truckee River.

Marvin Tebeau, an EPD chemist and permits officer, said Viking had obtained the contaminated cutting oil, used in machining work, from Atlantic Richfield. He said Viking has provided a "questionable" report indicating the PCB level in the oil was 200 parts per million. Federal law sets a 50 ppm limit.

The state division decided in late November to monitor a waste pond at Viking Metallurgical Inc. The pond apparently has been in use ever since the firm opened about 20 years ago, Gregory said.

Gregory added Viking officials on Tuesday advised the state of the possible PCB contamination at the pond, just 300 feet from the Truckee River.

Gregory said Reno-based Sierra Pacific Power Company was immediately notified of possible affects on its drinking water source. Sierra Pacific spokesman Mike Reed said there is "no evidence that the Reno-Sparks Water supply has been contaminated."

But Reed said Sierra Pacific decided to shut down its Glendale water treatment plant as a result. Instead of using Truckee water, the utility is relying on another treatment facility and wells.

▲ • ■

More PCB tests set for Truckee

CARSON CITY (AP) — More Truckee River tests for chemical PCB pollution are expected this week, following what a top state official termed "encouraging" results showing only trace amounts of the substance.

Nevada Conservation and Natural Resources Director Roland Westergard said Tuesday partial tests conducted by the U.S. Geologic Service at points near the Nevada-California border shows "PCB was just detectable in the sediments."

"This is somewhat encouraging because if there were higher concentrations of PCB, they would have settled out in the sediments," Westergard added.

The silt samples were taken just downstream from the Viking Metallurgical Inc. plant at Verdi — apparent source of some PCB — and also at Crystal Peak about two miles upstream.

Westergard said he's awaiting results of additional tests on water, more silt and on fish life.

A U.S. Fish and Wildlife spokesman has said trace amounts of PCB have been found in fish from the Truckee River in the Reno area since 1969.

PCB discovered in Truckee fish

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RENO (AP) — A U.S. Fish and Wildlife spokesman says traces of the chemical PCB have been found in fish from the Truckee River in this area since 1969.

Dave Lenhart also said Monday that his agency has not determined the PCB levels to be dangerous to humans. But he pointed out the tests are not conclusive.

In related action, Mike Reed of Sierra Pacific Power Co., which gets most of its Reno drinking water supply from the Truckee, said he wanted to stress that the water in the SP system is safe to drink as long as customers use tap water.

Sierra Pacific has urged its customers to cut back on water consumption by 10 percent as long as the utility is forced to rely on wells for its water supply.

Sierra Pacific has been using well water instead of Truckee water since the first indications that the river might be contaminated.

PCB, or polychlorinated biphenyls, can be toxic to humans. But a UN-Reno biochemist said the trace levels indicated from preliminary Truckee tests should pose no health problems.

Dr. Glen Miller termed the PCB situation "more a nip-in-the-bud reaction than a health concern."

Miller added that if the levels are about one part per million or less, "it probably isn't going to cause anyone to get sick, but it is an area of concern because we don't want to have these types of chemicals in our drinking water."

Preliminary tests released over the weekend showed traces of PCB in the Truckee near a Verdi jet engine parts firm which used PCB-laden oil. The oil had been dumped in a Viking Metallurgical Inc. waste pond just 300 feet from the Truckee.

EPA is accused in PCB leaks

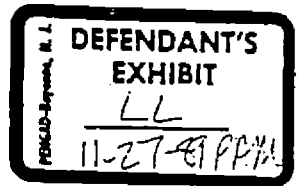
WASHINGTON — The Environmental Protection Agency was accused Thursday of failing to protect the public against leaks of highly toxic polychlorinated biphenyls — known simply as PCBs — from electric transformers. The charge was made before a House subcommittee by Rep. John Dingell, D-Mich., who said EPA's record in enforcing 1976 law banning most uses of PCBs was "inexcusable, intolerable and in clear violation of the law." Dingell was a key sponsor of the law banning the manufacture and most uses of the highly persistent chemicals — which are known to cause birth defects, miscarriages, stillbirths and other problems, possibly including cancer, when they enter the food chain.



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NEVADA POWER COMPANY



TO THE CUSTOMER:

There has been an electrical failure to Nevada Power Company's equipment located on, or adjacent to, your premises.

This failure released a small quantity of liquid polychlorinated biphenyls (PCBs). This liquid is considered a toxic environmental contaminant.

The accidental release of this material requires special handling, clean-up, and disposal by our personnel in accordance with U. S. Environmental Protection Agency regulations.

The special clean-up procedures, and repair of this equipment, began and will continue until all contaminated material has been removed and your property restored to environmentally-safe limits. To insure safe limits, vegetation and soil sampling will be conducted.

Upon initiating clean-up by our personnel, it may be necessary to remove vegetation or other landscaping. The company will replace all material removed; questions of this nature may be referred to our Claims Department.

Upon contact with this material, potential health hazards are associated. For your health and safety, and other persons or animals, avoid walking on, or contacting this material until our clean-up has been completed.

Watering of vegetation or soil will complicate the clean-up; please do



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not water until clean-up has been completed.

For further safety and health information see the reverse side of this notice, or call Nevada Power Company at 385-5627.

NEVADA POWER COMPANY -

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NEVADA POWER COMPANY

HUMAN HEALTH AND THE ENVIRONMENT

PCBs are harmful because once released into the environment they do not break apart into new chemical arrangements, instead they bioaccumulate in organisms throughout the environment. In addition, PCBs biomagnify in the food chain—that is, they accumulate in the tissues of living organisms and as they move up the food chain towards man their concentration increases. These facts are significant because PCBs have been shown to cause chronic (long-term) toxic effects in many species (not necessarily human) even when the exposure is very low concentrations.

KNOWN HEALTH EFFECTS OF PCBs

There are well documented tests which show PCBs cause, among other things, reproductive failures, gastric disorders, skin lesions, and tumors in laboratory animals.

Studies of workers exposed to PCBs have shown a number of symptoms and adverse effects including, but not limited to, chloracne and other epidermal disorders, digestive disturbances, throat and respiratory irritations, and severe headaches.

SAFETY PRECAUTIONS AND FIRST AID

The release of a small quantity of PCBs is not hazardous, provided that simple precautions are taken. Exposure can, and should be avoided until our clean-up is complete.

The breathing of vapor or fumes should be avoided. Minute concentrations of this contamination may be unpleasant or irritating, thus giving ample warning of their presence.

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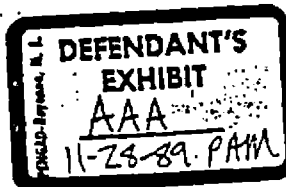
Like poison ivy, some people may be allergic and develop a rash, while others do not. If there is unavoidable contact with the skin alcohol, solvents, or waterless hand cleaner may be used to cleanse the skin prior to washing with ordinary soap and water; following the cleansing process, the application of cold cream will reduce the irritation that may result from contact.

If the liquid contacts the eyes, they may be irrigated with water, and then examined by a physician (a drop of castor oil has been found to reduce irritation).

Ingestion of the material is generally not considered a problem. Should accidental ingestion occur, a physician should be consulted. Hands should be washed in warm water and soap before eating, drinking, smoking, or using toilet facilities.

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RECEIVED
REGIONAL OFFICE

REGION IX

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IX

In re) Docket No. TSCA-IX-002C
NEVADA POWER COMPANY,)
Respondent.)
CONSENT AGREEMENT AND ORDER

CONSENT AGREEMENT

I

This civil administrative action was instituted pursuant to Section 16(a) of the Toxic Substances Control Act (TSCA), 15 U.S.C. 2615(a). The action was initiated by a Complaint and Notice of Opportunity for Hearing issued on October 24, 1979 charging violations of Section 15(1)(C) of TSCA, 15 U.S.C. 2614(1)(C). The Complainant is the Director, Enforcement Division, United States Environmental Protection Agency (EPA), Region IX. The Respondent is Nevada Power Company, Las Vegas, Nevada.

II

Respondent admits the jurisdictional allegations of the Complaint and Notice of Opportunity for Hearing.

III

Respondent neither admits nor denies the specific factual allegations contained in the Complaint and Notice of Opportunity for Hearing.

IV

1. This compromise is in part in recognition that Respondent has devised and implemented a plan for the cleanup of spills and other uncontrolled discharges of PCBs (PCB spill plan). The PCB spill plan is contained in Respondent's appropriate operation manuals, orders, or other procedures.

ANNO326



10/1/80

REGION II

1 2. In addition to the requirements of 40 C.F.R. Part 761, the
2 PCB spill plan shall, by October 1, 1980, contain provisions
3 which provide for the following:

4 a. The cleanup of spills and other uncontrolled discharges
5 of PCBs to less than 50 ppm PCBs shall commence immediately upon
6 Respondent's knowledge of the spill or discharge.

7 b. After the cleanup of a spill or other uncontrolled
8 discharge of PCBs, samples shall be collected and analyzed to
9 ensure that the spill or discharge was cleaned up to less than
10 50 ppm PCBs.

11 c. For a spill or other uncontrolled discharge of PCBs
12 onto property not owned or operated by Respondent, the owner or
13 operator shall be notified immediately upon Respondent's learning
14 of the spill or discharge. The owner or operator shall be
15 informed of the health effects of exposure to PCBs, Respondent's
16 PCB spill plan, and that no cleanup should be undertaken by the
17 owner or operator.

18 V

19 Respondent waives the right to a hearing on any issue
20 contained in this Consent Agreement and Order.

21 VI

22 Respondent consents to the issuance of this Consent
23 Agreement and Order.

24 NEVADA POWER COMPANY

25
26 Sept. 25, 1980
27 Date

M. L. McArthur
Respondent, Vice President and Chief Counsel

28
29 Oct. 8, 1980
30 Date

Clyde B. Eller
Director
Enforcement Division

31
32
A000337

10/10/80

REGION IN

ORDER

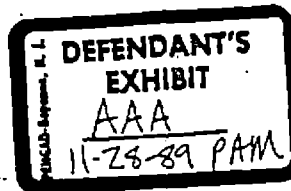
It is hereby ordered that Respondent shall, within sixty (60) days of receipt of this Consent Agreement and Order, pay by cashier's or certified check, payable to the United States of America, a civil penalty in the amount of one thousand two hundred fifty dollars (\$1,250.00). This order shall become effective immediately.

10/10/80

Sheila M. Prindiville

Sheila M. Prindiville
Acting Regional Administrator

A000338



DEFENDANT'S EXHIBIT

REGION IX

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION IX

In re) Docket No. TSCA-IX-0020
NEVADA POWER COMPANY,)
Respondent.) CONSENT AGREEMENT
AND ORDER

CONSENT AGREEMENT

I

This civil administrative action was instituted pursuant to Section 16(a) of the Toxic Substances Control Act (TSCA), 15 U.S.C. 2615(a). The action was initiated by a Complaint and Notice of Opportunity for Hearing issued on October 24, 1979 charging violations of Section 15(1)(C) of TSCA, 15 U.S.C. 2614(1)(C). The Complainant is the Director, Enforcement Division, United States Environmental Protection Agency (EPA), Region IX. The Respondent is Nevada Power Company, Las Vegas, Nevada.

II

Respondent admits the jurisdictional allegations of the Complaint and Notice of Opportunity for Hearing.

III

Respondent neither admits nor denies the specific factual allegations contained in the Complaint and Notice of Opportunity for Hearing.

IV

1. This compromise is in part in recognition that Respondent has devised and implemented a plan for the cleanup of spills and other uncontrolled discharges of PCBs (PCB spill plan). The PCB spill plan is contained in Respondent's appropriate operation manuals, orders, or other procedures.

A000339

2. In addition to the requirements of 40 C.F.R. Part 761, the PCB spill plan shall, by October 1, 1980, contain provisions which provide for the following:

a. The cleanup of spills and other uncontrolled discharges of PCBs to less than 50 ppm PCBs shall commence immediately upon Respondent's knowledge of the spill or discharge.

b. After the cleanup of a spill or other uncontrolled discharge of PCBs, samples shall be collected and analyzed to ensure that the spill or discharge was cleaned up to less than 50 ppm PCBs.

c. For a spill or other uncontrolled discharge of PCBs onto property not owned or operated by Respondent, the owner or operator shall be notified immediately upon Respondent's learning of the spill or discharge. The owner or operator shall be informed of the health effects of exposure to PCBs, Respondent's PCB spill plan, and that no cleanup should be undertaken by the owner or operator.

V

Respondent waives the right to a hearing on any issue contained in this Consent Agreement and Order.

VI

Respondent consents to the issuance of this Consent Agreement and Order.

NEVADA POWER COMPANY

Sept. 25, 1980
Date

W. Lee Matterson
Respondent, Vice President and Chief Counsel

Oct. 8, 1980
Date

Clyde B. Eller
Director
Enforcement Division

A000340

ORDER

It is hereby ordered that Respondent shall, within sixty (60) days of receipt of this Consent Agreement and Order, pay by cashier's or certified check, payable to the United States of America, a civil penalty in the amount of one thousand two hundred fifty dollars (\$1,250.00). This order shall become effective immediately.

10/10/80

Sheila M. Prindiville

Sheila M. Prindiville
Acting Regional Administrator

A000341

SF Blaze Forces Escape Of Dangerous Chemical

SAN FRANCISCO (AP). — Firemen hacked away at a log-wrapped city pier Monday to reach a four-alarm blaze that gutted a power station and triggered the escape of small amounts of a dangerous chemical.

Officials said PCB, a

substance used in electrical equipment which has been linked to cancer, vaporized in the intense heat, and officials were concerned firefighters might have inhaled the fumes.

The chemical was contained inside electrical transformers,

whose gaskets opened in the fire. —

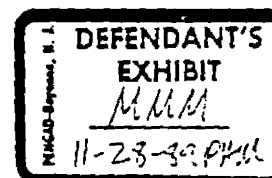
A0000342



N 03171

NEVADA POWER COMPANY

December 1, 1980



TO: Keith Grant
FROM: Donald Fabbi *D.F.*

SUBJECT: System-Wide PCB Transformers/Testing and Reclamation

Sunohio has announced the first commercial portable PCB destruction process for transformer and capacitor fluids.

This new process, called "PCBX", could represent a significant breakthrough in our PCB disposal problem. The process is basically a chemical disposal method that breaks apart the very stable PCB molecule and rearranges it to form other chemical compounds reported to be harmless and environmentally safe.

This process could have important advantages over our present inerting (RTE, R-Temp) process. It is a totally enclosed process that filters and restores the oil for reuse, free from PCB's.

Perhaps the most important feature is, this method does not require transportation, storage, disposal, or further handling of PCB's.

The process is portable and self-contained on a tractor-trailer that can be moved to the transformer containing PCB fluids.

In my view, we should seriously consider this process as a better alternative to the present RTE, R-Temp inerting. In addition, we should delay any further inerting of the transformers on our system (such as at the Hilton and Horseshoe vaults) unless we are presented with an unusual problem such as a "leaker" (Clark Station, Unit #2). Labor, replacement oil, and disposal costs of the PCB oil from the present R-Temp arrangement is significant. Another consideration is, even though our employees work in a controlled safe environment while replacing the PCB oil with the R-Temp fluid, they share a real anxiety about an accidental release or possible health exposure.

Presently, we are faced with the ultimate disposal of 14,807 gallons of PCB liquid in transformers located in our customer vaults and at our power plant locations. Currently we are faced with an enormous problem of proper disposal in order to comply with the regulations currently in effect.

I believe the Sunohio process is a better alternative and we should study it, pending their imminent EPA approval.

DF/re
Enclosures

cc: J. McCarthy

A000343

N 12407



November 24, 1980

Mr. Donald G. Fabbi
Safety Director
Navada Power Company
Fourth Street & Stewart Ave.
P.O. Box 230
Las Vegas, Nevada 89151

Dear Sir:

At your request we are forwarding a copy of our recent Press Release on PCBX.

We are excited about this new process, however, are faced with the reality of waiting for EPA approval before it becomes commercially viable. In this regard, we are practicing patience.

We also want you to know that Sunohio provides comprehensive field services for high voltage substations. We specialize in the following areas:

TRANSFORMER OIL/PCB TESTING AND RECLAMATION

PCB PROCESSING AND DISPOSAL

TRANSFORMER ELECTRICAL TESTING

SWITCHGEAR TESTING AND CALIBRATION

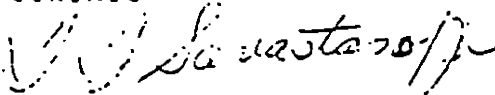
SUBSTATION REPAIRS AND MAINTENANCE

Of special interest is our capability in repairing PCB transformers so that leaks are corrected and prevented from contaminating the environment.

We thank you for your interest in Sunohio and look forward to communicating with you in the future.

Very truly yours,

SUNOHIO



T. F. Savastano
General Manager

TFS/cg

Encl.

N 12408

A000344

FIELD SERVICES
FOR ELECTRIC
POWER SYSTEMS

Transformer Fluid
Testing and
Reclamation

PCBX*

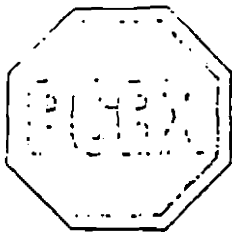
Substation
Repairs and
Maintenance

Switchgear
Testing and
Calibration

Transformer
Electrical Testing

Transformer
Installation and
Vacuum Filling

Preventive
Maintenance
Programs



NEWS RELEASE

SUNOHIO

1700 GATEWAY BLVD. S.E./CANTON, OHIO 44707

PCBX IS A SERVICE MARK OF SUNOHIO

FOR RELEASE:

Thursday, September 11, 1980

FOR FURTHER INFORMATION:

Dave Gibson
216/453-4785

SIGNIFICANCE:

PCBX*--FIRST COMMERCIAL PCB DESTRUCTION
PROCESS READY FOR EPA OPERATING APPROVAL--
IS SAID TO BE LESS COMPLEX, FASTER AND
MORE DESIRABLE THAN OTHER PROCESSES. EPA
TO WITNESS DEMONSTRATION OCTOBER 2, 1980.

SUNOHIO ANNOUNCES PCBX

CANTON, OHIO--A ready-to-go portable process to destroy highly toxic PCBs (polychlorinated biphenyls) contained in electrical transformer and capacitor fluids has been announced by Sunohio, Canton, Ohio. Announcement was made by Norman E. Jackson, Sunohio's Chairman.

"The first commercial-scale PCBX unit has now been completed and tested. This is the prototype for a proposed fleet of similar vehicles to clean up PCBs nationwide. It will be used Thursday, October 2 for a field demonstration at Massillon, Ohio. This demonstration will be witnessed by a team of some 18 EPA (Environmental Protection Agency) officials. In addition to headquarters representatives, EPA personnel will be present from each of the ten regional EPA offices," Jackson said.

*PCBX is a service mark of Sunohio.

Continued on Page 2.

N 12400

A 00345

Page 2

Similar presentations of the apparatus at work in actual field application will be given in subsequent weeks for the media and industrial representatives.

The new process, called "PCBX," has previously been fully disclosed to the EPA in Washington, D.C. On June 5, 1980, a team of seven representatives of Sunohio presented the new process in full detail to 14 EPA officials, as well as to Congressional representation. As a result of this presentation, Steven D. Jellinek, Assistant Administrator of EPA, expressed the belief that the PCBX process represented a potentially significant breakthrough to the vexing PCB-disposal problem. He requested a full field demonstration by Sunohio and appointed an EPA task force, headed by William Gunter, to expedite evaluation and approval.

While the EPA has been asked to treat as confidential certain proprietary aspects of the process, PCBX is basically a chemical disposal method that breaks apart the very stable and toxic PCB molecule, rearranging it to form other chemical compounds that are either known or believed to be harmless and environmentally safe. According to Jackson, the PCBX process has important advantages over other known alternate methods of disposal. "Compared to incineration, PCBX is safer environmentally, since it is performed in a totally enclosed liquid system at

Continued on Page 3.

N 12410

A000346

very low temperature and pressure. Also, valuable transformer oils, contaminated with PCBs, are not burned up and wasted, but rather are cleaned up and restored to new condition for reuse, completely free of PCBs.

"Compared to another recently announced chemical method, PCBX is less complex, works faster and more completely, and will be more practical, convenient and economical in actual applications. PCB chemistry was disclosed by the Japanese in a technical journal in 1978, but we rejected this approach as being too complex for practical and economic application," Jackson said.

Perhaps the most important feature of the new technique is that it is the only method that does not require transportation or further unnecessary handling of dangerous PCBs. The entire process from the start was designed to be portable. It is fully self-contained and mounted on a standard 40-foot tractor-trailer that can be moved directly to contaminated transformers, capacitors, PCB storage areas, or anywhere PCBs are already located.

The process can handle both highly concentrated as well as very dilute amounts of PCBs. Tests of the concentration of PCBs in processed fluids are done by sensitive gas chromatography scans and show that there are very low to no detectable PCBs

Continued on Page 4.

N 12411

A000347

whatsoever in fluids treated by the PCBX process. These results have been repeated on all kinds of PCB-contaminated oils as typically encountered in the field.

Jackson further stated that Sunohio's policy has been to withhold public announcement until EPA approval seemed imminent. "No real purpose would be served by announcing a solution to an important problem if we couldn't offer it to our customers for awhile. It is timely to announce our discovery and accomplishments at this time, not only because other process announcements have been made recently, but also because our demonstration for EPA is now imminent and, hopefully, their approval will be forthcoming in the very near future."

Sunohio serves the industrial and utility industries by performing specialized maintenance and repairs on electrical substations and reclaiming electrical fluids on site for reuse. Sunohio is a partnership jointly owned by subsidiaries of Ohio Transformer Corporation, Louisville, Ohio, and Sun Company, Radnor, Pennsylvania. The PCBX process was researched by Dr. Oscar L. Norman of Sun, developed to a fully portable, commercial-scale operation by Ohio Transformer under the direction of Mr. Otis D. Jordan, and will be operated and licensed commercially by Sunohio.

-oOo-

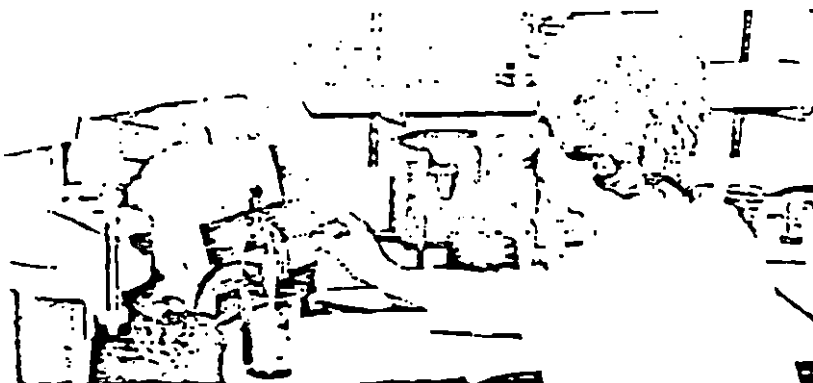
N 12412

A000348

With America so dependent on electric power, unexpected interruptions can cause heavy losses. To minimize these losses many utilities, industrial plants, schools, hospitals, and other institutions are placing increasing emphasis on proper maintenance of electric power equipment.

SUNOHIO provides a complete field capability for servicing electric power equipment.

TRANSFORMER OIL/PCB TESTING & RECLAMATION



Using efficient and modern equipment, SUNOHIO will completely reclaim your deteriorated transformer oil with no loss in time or production. Generator equipped mobile reclaimers are connected to the top and bottom valves of the transformer with hoses. The oil is heated to 180°F and pumped through a bed of Fuller's Earth which removes harmful contaminants, and clarifies the color. The oil is then processed through vacuum chambers where moisture and gases are removed. Clean, dry oil is then returned to the transformer where (due to the circulation and solvent action of the heated oil) residue is removed from the windings, core, and sides of the transformer tank.

TRANSFORMER INSTALLATION

- CONNECTIONS
Primary and Secondary
- ACCEPTANCE TESTING
- VACUUM FILLING

For modern high voltage transformers, a high vacuum is applied to the tank prior to oil filling. The transformer is then filled with heated dehydrated oil while the high vacuum is maintained. This assures dry oil with the highest possible dielectric value and maximum penetration into the transformer's solid insulation.

SUNOHIO field technicians will come to your plant and draw samples from your oil or PCB filled electrical equipment with POWER ON. The following comprehensive A S T M screen tests for transformer fluids are then performed in our laboratory.

1. A.S.T.M. D1500-Color This is a test in which a sample amount of oil is compared to a graduated color standard, thereby enabling our technician to classify the sample under a standard A S T M. color.

2. A.S.T.M. D1524 Visual-Sludge This is a visual test to determine the presence of carbon, free water, insulating material, or insoluble sludges caused by deterioration of oil or PCB fluid.

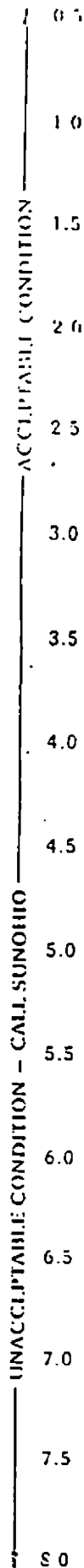
3. A.S.T.M. D877 - Dielectric Voltage Breakdown This test is performed to determine the electrical insulating "strength" of oil or PCB fluid.

4. A.S.T.M. D1534 - Neutralization Number (Acid) This test determines the neutralization number or acid content in transformer oil or PCB fluid.

5. A.S.T.M. D971 - Interfacial Tension (I F T) testing performed to determine the amount of polar and non-polar compounds in transformer oil.

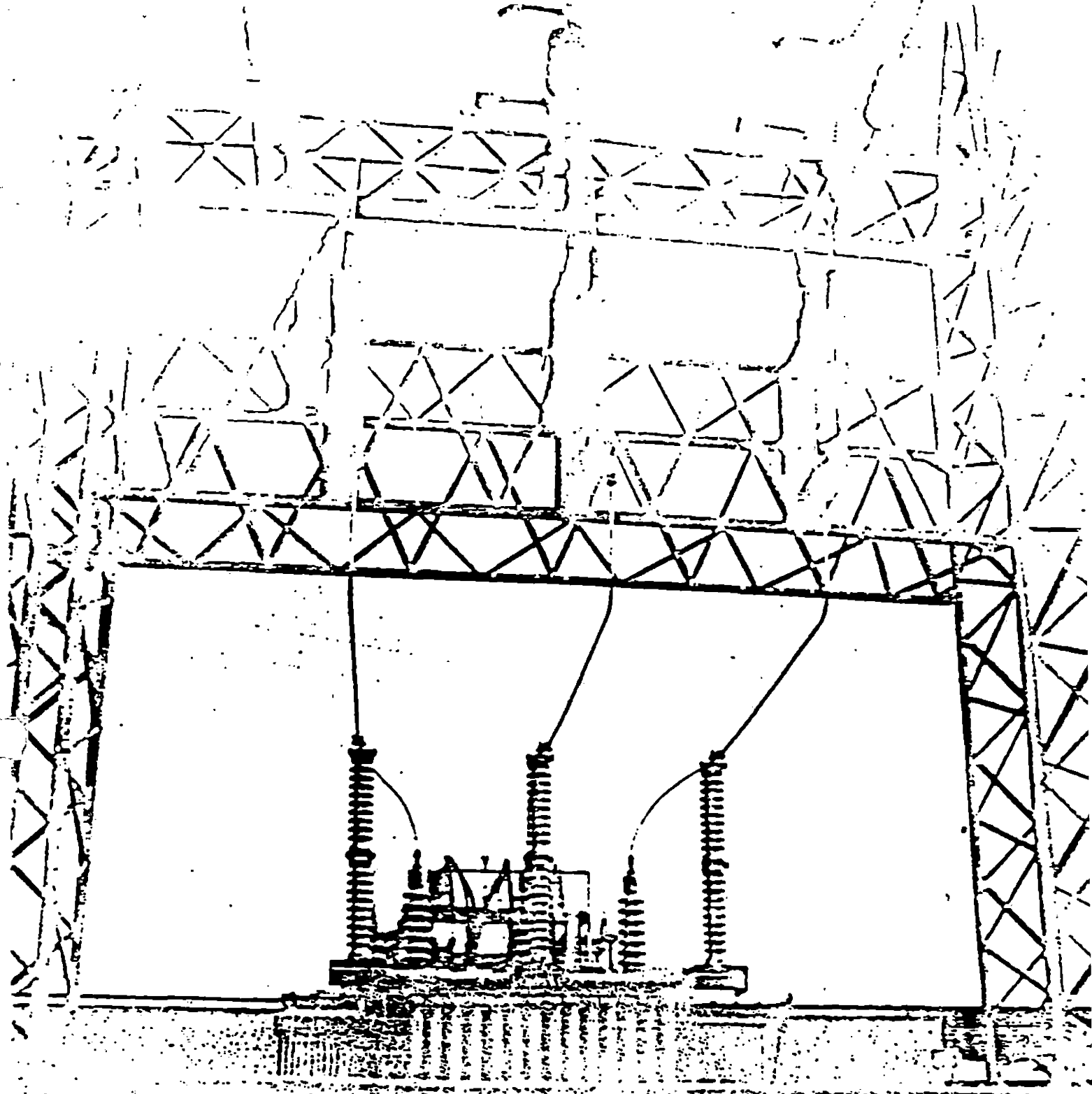
6. A.S.T.M. D1298 - Specific Gravity - D1810 for PCB fluids This test is useful to the field technicians for determining the weight of oil or PCB fluid to accurately compute the neutral number in mg KOH/g. It has no direct indication to the quality of oil or PCB fluid, but is useful for identifying PCB's and oil contaminated with PCB's.

TRANSFORMER OIL - COLOR COMPARISON CHART



N 12413

A000349



FIELD SERVICES FOR ELECTRIC POWER SYSTEMS

TESTING • REPAIR • PREVENTIVE MAINTENANCE
Transformers, Switchgear and Related Equipment

SUNOHIO

Partnership of Sun Company and Ohio Transformer Company Subsidiaries

AD000350

PCB TRANSFORMER INVENTORY - CUSTOMER VAULTS

Location	Transformer Manufacturer	Company Transformer Number	Size KVA	Gallons of PCB Fluid	Total lbs. of PCB Fluid at Location Approximately	Total Kilograms PCB Fluid at Location Approximately	Vault Contains		Metal Tray
							Sump Pump	Floor Drain	
Four Queens Hotel	Pennsylvania	5700 5701 5702	500 500 500	Aroclor 711 711 711	24380	11082			X
Hilton Hotel Main Transformer Vault	Westinghouse	F476 F477	2500 2500	Inerteen 615 615	14059	6390		X	
McCarran Field Underground Vault	McGraw Edison	H327 H328	2500 2500	Elmex 615 615	14059	6390	X		
Horseshoe Club Underground Vault	Westinghouse	8094 8095 8096	833 833 833	Inerteen 395 395 395	13545	6157		X	
Spare Transformer at Pole Yard	Westinghouse	7938	833	Inerteen 395	4515	2052	N/A	N/A	N/A
Spare Transformer at Pole Yard	Bear State	6618	500	Aroclor 237	2709	1231	N/A	N/A	N/A
Boulevard Mall *(1) Underground Vault	Westinghouse	E666 E667	2000 2000	Inerteen 425 425	9716	4416	X		
Western Hotel	Westinghouse	G600	750	Inerteen 355	4058	1844			X
North Las Vegas City Hall	Allis Chalmers	E317 E318 E319	167 167 167	Inlorextol 237 237 237	8127	3694		X	

*(1) Replaced PCB Fluid
November 5, 1980

8326
Total Gal.

95168
Total lbs.

43256
Total kg.

PCD TRANSFORMER INVENTORY - GENERATING STATIONS

Sunrise Station 3000 L. Vegas Valley	Westinghouse 4,160 V	SERIAL #	1500	<u>Inerteen</u> 595	6801	3091		N/A	
		7376501							
Clark Station Cor. Emerald & Unit Stephanie St. #1	General Electric 4,160 V	0173841	1000	<u>Pyranol</u> 425	4858	2208		Not in Immediate Area	N 12313
Clark Station Cor. Emerald & Unit Stephanie St. #2	General Electric 4,160 V	C500157	3750	<u>Pyranol</u> 1188	13577	6172		Not in Immediate Area	
Clark Station Cor. Emerald & Unit Stephanie St. #3	Allis Chalmers 4, 160 V	3298203	1500	<u>Chlorextol</u> 457	5224	2374		Not in Immediate Area	
Clark Station Cor. Emerald & Unit Stephanie St. #2	General Electric 4,160 V	C501946	1500	<u>Pyranol</u> 520	5944	2702		Not in Immediate Area	A000252
Reid Gardner Hoapa, Nevada Aux. Floor Unit #1	Westinghouse 4,160 V	7023522	1000	<u>Inerteen</u> 336	3840	1746		Not in Immediate Area	
Reid Gardner Hoapa, Nevada Aux. Floor Unit #2	General Electric 4,160 V	F959057A	1000	<u>Pyranol</u> 330	3772	1715		Not in Immediate Area	
Reid Gardner Hoapa, Nevada Aux. Floor Unit #3	Westinghouse 4,160 V	PBV721302	1000	<u>Inerteen</u> 578	6607	3003		Not in Immediate Area	
Reid Gardner Coal Yard Control Room	Westinghouse 4,160 V	PBV721401	750	<u>Inerteen</u> 260	2972	1351			
Reid Gardner Coal Yard Control Room	Westinghouse 4,160 V	70233844	750	<u>Inerteen</u> 240	2743	1247			

4929
Total Gal.56338
Total lbs.25609
Total kg.

PCB TRANSFORMER INVENTORY - GENERATING STATIONS

Reid Gardner Station Hoopa, Nevada Unit #1 - Westside	General Electric 13.8 KV	F260506	385	<u>Pyranol</u> 350	4001	1818		Not in Immediate Area	
Reid Gardner Station Hoopa, Nevada Unit #2 - Westside	ITE Corporation	21503R01	1000	341	3898	1772		Not in Immediate Area	N 12417
Reid Gardner Station Hoopa, Nevada Unit #2 - Westside	ITE Corporation	21503B01	1000	341	3898	1772		Not in Immediate Area	
Reid Gardner Station Hoopa, Nevada Unit #3 - Westside	Hestingham 4,160 V	PBV721501	1000	<u>Inerteen</u> 255	2915	1325		Not in Immediate Area	
Reid Gardner Station Hoopa, Nevada Ash Pump House	Hestingham 4,160 V	PBV721601	750	<u>Inerteen</u> 265	3029	1377		Not in Immediate Area	

1552
Total Gal.

17741
Total lbs.

8064
Total kg.

NOTE: Figures Based on 11.43 lbs/gal. and rounded
off to nearest whole lb.

14807
Grand Total
Gallons PCB
Fluid in all
Transformers

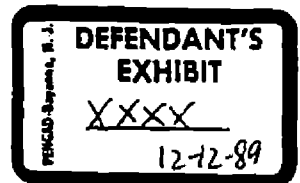
169247
Grand Total
lbs PCB Fluid
in all
Transformers

76929
Grand Total
kgs PCB Fluid
in all
Transformers

APPENDIX



NEVADA POWER COMPANY



December 9, 1980

Notice of Results: PCB Personnel Sampling

Employee: Luis Pineiro Survey # 034
Sample Date: 11-03-80 & 11-04-80 Date of Results: 11-26-80

Attached is a copy of your results on personnel sampling for occupational exposure to polychlorinated biphenyls, which was conducted on the above date.

This letter notifies you that your results reveal an exposure of less than allowable limits. Current limit for exposure to this chemical rests at .5 mg per cubic meter for eight hours. Since your exposure is within the allowable limits, you should not be unnecessarily concerned.

Nevada Power Company is interested in your good health; therefore, be sure you use all protective equipment provided and follow the established safety procedures.

If you should have any questions concerning this letter, please contact your supervisor or the Safety Department.

Sincerely,

NEVADA POWER COMPANY

Donald G. Fabbi

Donald G. Fabbi
Safety Director

DGF/re

Enclosure

cc: Employees personnel file
Supervisor

A000254



04470 February

Risks of dumping learned too late

By Tom Tiede

SMITHFIELD, N.C. (NEA) — The whole sad thing began for Vicky Jordan in the summer of 1978. She was a newly wed housewife then, and well along in her first pregnancy. She was healthy, happy and excited with her prospects, and the pediatrician was confident that everything was progressing normally.

Then a quiet disaster struck.

Three truckdrivers who were hauling polychlorinated biphenyls to a waste facility in Pennsylvania decided to dump them instead in North Carolina. PCB's are used to fashion electric components, but are also known to be carcinogenic; the drivers spilled 30,000 gallons of the poison over 200 miles of roads.

One of the roads, state highway 210, runs in front of Jordan's Smithfield home. At the time the PCB's were dumped she was in the habit of walking along the road for daily exercise. She continued to do this for three weeks after the spilling, until authorities told her of the risks.

By then, she says now, it was too late. A short while later Jordan gave birth to a son who was three months premature. She remembers that the baby cried a little, and breathed for a while, but that was all it knew of life; she says it just wasn't strong enough, and died in a few minutes.

Jordan and her husband, an Air Force mechanic, were naturally devastated. They were also puzzled. There was no history of birth problems in either of their families, and until the PCB's were dumped the pregnancy was quite routine. They decided then that the chemicals were responsible.

Not having made the connection, there was nothing they could do about it. The pediatrician agreed that PCB's could have been involved, but government health officers refused to confirm it. Jordan says the government was of very little help. "The only thing they said was to wash all my vegetables."

Meantime the road menace continued. State authorities promised to dig the contamination up, if necessary, to protect the well-being of affected people, but the early rhetoric soon folded into legal and financial complexities. Eventually it became clear that no one really knew what to do about the PCB's.

Some people who lived along the poisoned roads talked briefly about moving. But that reaction was considered to be impractical. Jordan says the property values had fallen, for one thing, at a time when mortgage interest rates were high, thus most people found they were more or

Jordan says the second loss was even worse than the first. She still keeps the baby's picture in a locket around her neck. "I think it's like murder," she says. "Those men who dumped the chemicals knew they were doing wrong. It's like they just took a gun or a knife and did what they did."

The men who dumped the PCB's are Robert Burns and two sons. They told a North Carolina jury last year that they could not take the chemicals to a safe storage because they ran out of transportation containers. They pleaded guilty, but have not been punished; there has been a delay in sentencing.

There has also been further delay in the disposal of the toxins. The state has spread charcoal over the contaminated roads, but a permanent cleanup seems nowhere in sight. Several suits have been filed in the matter, yet the PCB's remain exactly where they were dumped more than two years ago.

As for Vicky Jordan, she is pregnant again, seven months, and is a patient at Duke University's high risk clinic. She says she is nervous and worried, but wants a child very much.

less stuck in place.

So, angry but powerless, the Jordans decided to try for another baby. She became pregnant for the second time in October of that year, and she says she took every precaution. She watched what she ate, she increased her visits to the pediatrician, and she tried to stay away from state highway 210.

She couldn't avoid the road altogether, however. In dry weather its dust would rise and roll over her property, and during rains there were runoffs into the yard. Each time an automobile crept into the Jordan's driveway, in fact, it may have dragged some of the polychlorinated biphenyls along.

In May of 1979 Jordan gave birth again. This time the baby was two months early, and was burdened with physical defects. It had congenital heart disease (two valves instead of four), and a bilateral cleft (no upper lip or palate). The baby also had a detached esophagus, and a collapsed diaphragm.

The child lived for eight months. The Jordans named her Patricia Dale. Surgery was performed to correct some of the abnormalities, and hope was kindled for a brief time, but in the end it was not enough. The tiny girl went into a coma in her crib, and died in the hospital (of heart complications).

AT000356



N 03172

Vegas SUN

LAS VEGAS, NEVADA, THURSDAY, FEBRUARY 26, 1981

Toxic Wastes

Head Here

Beating Deadline Is Goal

By MARY MANNING
SUN Staff Writer
(c) 1981 Las Vegas SUN

Trucks from several Western states will drop loads of toxic PCB at the Beatty hazardous waste dump Thursday and Friday in an effort to beat a March 1 federal deadline banning burial of the liquid chemical.

The Beatty dump site, 90 miles northwest of Las Vegas, is the only facility in the Southwest licensed to handle the suspected carcinogenic substance. Environmental Protection Agency officials say. The dump is operated by USEcology of Louisville, Ky. A company spokesman said 30 shipments totaling about 200,000 gallons are expected in the next two days.

*See Related
Story, Page 15*

But new federal regulations effective March 1 require liquid PCB to be transported to a newly approved incinerator in Arkansas for burning.

"A lot of people will be cramming into Beatty to dump PCB in the next few days," said Jerry Gavin, an agency environmental scientist in San Francisco and a PCB expert.

Gavin said many Western utility companies are sending PCB-filled capacitors to Beatty to avoid high shipping costs to Arkansas. After March 1, only solids such as contaminated soil or rags used to mop up a chemical spill will be accepted at landfills.

Capacitors are used to insulate transformers on top of power poles. Liquid PCB tolerates temperatures exceeding 1,000 degrees Centigrade before burning, making it an excellent insulator.



A000357

N. 03167

Firm Beating Deadline

Toxic Waste Due Here

(Continued From Page 1)

The Beatty dumpsite received 471,496 gallons of PCB in 1979, 584,736 gallons in 1980 and 69,859 gallons in January 1981, according to Tom Gerdis, director of public affairs for USECology.

"Under federal regulations, the liquid in sealed containers — such as capacitors — should be buried in clay-lined or plastic-lined landfills, so it won't get into the groundwater," Gavin said.

Utah Power and Light Co. is scheduled to ship 460 capacitors, each with about 500 gallons of PCB, from Salt Lake City and Ogden through Las Vegas and on to Beatty Thursday.

"We've been sending them, truckload after truckload, for the last few months," said a company spokesman.

After March 1, PCB-filled capacitors will be emptied onsite, according to federal officials. The liquid chemical will be shipped to the incinerator, while the empty capacitors will be transported to landfills such as Beatty.

Currently the capacitors are packed in one-gallon containers surrounded by a cocoon of absorbent materials, boxed and secured on trucks with steel bands, according to Dave Mills, environmental engineer for the Utah company.

PCB is a stable, oily man-

ufactured chemical that doesn't break down when released in the environment, Gavin said.

"There's no way to flush it from the human body, since it's stored in fat tissue," Gavin said. "When it's released in the food chain, it's there forever."

PCB is used as a coolant and insulator, but the dangers of the 50-year-old chemical have been recognized only in the last 10 years, according to Gavin.

The symptoms of about 1,000 Japanese exposed to a PCB leak in 1978, included respiratory distress, liver lesions and sexual dysfunctions, Gavin noted.

About 1.4 billion pounds of PCB have been manufactured since 1929, Gavin said. Of that total, 200 million pounds are contained in landfills, 100 million pounds were exported from the United States to foreign countries, and 300 million pounds are locked into the environment, Gavin explained.

Another 750 million pounds of the chemical is sealed in capacitors, Gavin said. But that doesn't include other power generating equipment such as generators in hospitals, prisons, military bases or airports, Gavin noted.

PCB's toxic effects on hu-

man beings aren't immediate, according to Dean Gillam, chief of the hazard assessment section of the Environmental Protection Agency in Denver, Colo.

In laboratory animals the chemical is a suspected carcinogen, has changed chromosomes and fetus cells,

Gillam said. But there are long-term latent effects of chronic exposure to PCB.

In humans PCB causes skin lesions, tumors on the liver and sexual dysfunction, Gillam said.

We don't know that it changes human genes, Gillam said.

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