EXHIBIT 42

EPA 560/6-76-005

PCBs IN THE UNITED STATES INDUSTRIAL USE AND ENVIRONMENTAL DISTRIBUTION

TASK I

FEBRUARY 25, 1976

FINAL REPORT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF TOXIC SUBSTANCES
WASHINGTON, D.C. 20460

SECTION II
SUMMARY

1.0 PRODUCTION, USAGE, AND DISTRIBUTION OF PCBs

1.1 Overview of PCBs Industrial Usage in the United States

Over the past four years the domestic production and use of polychlorinated biphenyls (PCBs) have been approximately constant with averages of 40 million pounds per year for production and 33 million pounds per year for domestic sales. During this period Monsanto Industrial Chemicals Corp., the sole domestic producer, has supplied approximately 99 per cent of the domestic market. Monsanto sells several PCB mixtures under the generic trade name Aroclor, and purchase has been limited to intended use in nominally closed electrical systems (transformers and capacitors) since 1971 under voluntary restrictions imposed by Monsanto.

The remainder of the domestic usage depends on imported PCBs, most of which originate in Italy and the remainder in France. Decachlorobiphenyl is imported from Italy for use in investment casting wax, and the material imported from France is used in cooling systems of mining machinery.

Of the domestic sales of PCBs, 65 to 70 per cent are to manufacturers of capacitors, and the remainder to manufacturers of transformers. Transformers, which contain 2,000 to 2,500 pounds of PCBs on the average (present as a 60 to 70 per cent component of mixtures with trichlorobenzene called Askarels) are used primarily to change voltages during the transmission and distribution of electrical power. Approximately five per cent of the transformers in service in this country contain PCBs; most transformers contain mineral oil instead of PCBs. Capacitors containing PCBs are of two general types; small capacitors which are built into electrical appliances such as fluorescent lights, TV sets and small motors, and large capacitors which are used as separate units in electrical power distribution systems and with large industrial machinery such as electric motors and welding machines. PCBs are used in about 95 per cent of U.S.-produced liquid impregnated capacitors (most small capacitors in radios and other electronic equipment are solid-state units).

PCBs are typically used in transformers where protection against fire is of paramount importance. Use of PCBs in capacitors is based on a number of factors, but fire protection and service life appear to be the most important. Industry codes, such as the National Electrical Code, specify the use of PCB-filled transformers and capacitors under a number of conditions. These codes will serve as institutional barriers to rapid reductions in PCBs usage, but at present there are also technical barriers to substitution of other materials for PCBs in electrical equipment.

The above overview of current PCBs usage in the U.S. is summarized by Figure 1.0-1, which traces domestic PCBs production and importation through first tier usage and distribution of PCBs - containing products.

1.2 Cumulative PCBs Production and Usage in the United States

Estimates developed for total PCBs production and utilization in the U.S. since their introduction to industry in 1929-30 are presented in Table 1.2-1. These data define the estimated proportions of PCBs used in various applications, and an accounting, based on available data plus estimates, of the current distribution of this material. Of the roughly 1.25 billion pounds purchased by U.S. industry, it is estimated that only 55 million pounds, or 4.4 per cent, have been destroyed by incineration or by degradation in the environment. About 60 per cent of the total domestic sales is still in service, almost all in capacitors and transformers. The remainder, about 44 million pounds, are in the environment; it is estimated that 290 million pounds are in landfills or dumps and 150 million pounds are "free" in the general environment (air, water, soil, sediments) and presumably available to the biota.

Some of the values in Table 1.2-1 are relatively well-established, while others are gross estimates resulting from a lack of data in the area. The estimated reliability for each value presented is shown on the table. For instance, the PCBs usage in carbonless copy paper is a firm value obtained from the only producer (NCR), where as the amount of PCBs environmentally degraded could conceivably range from a low value to the total of mono-, di-, and trichlorobiphenyl utilized but not still in service. The value for U.S. production could not be

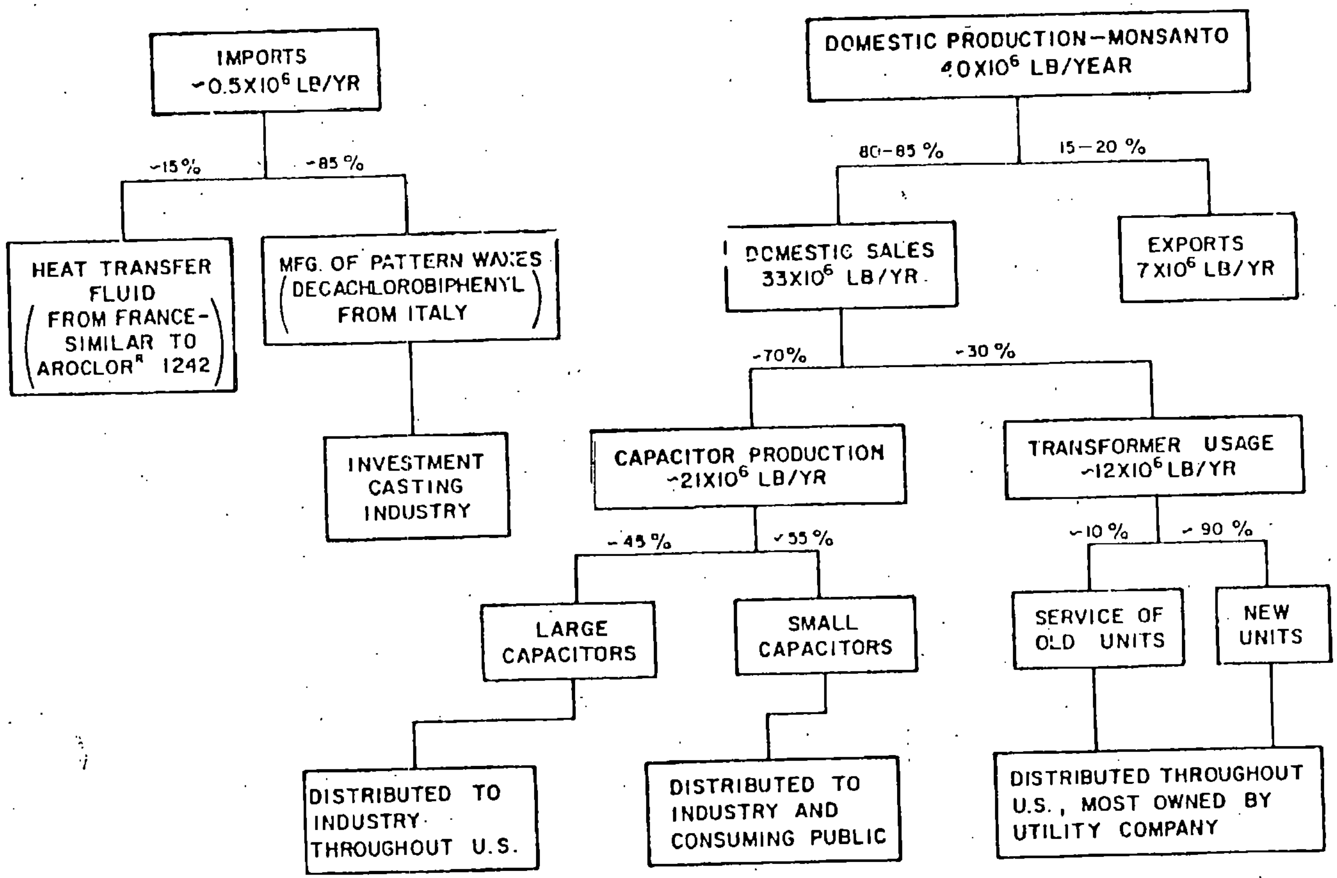


FIGURE 1.0-1. U.S. PRODUCTION AND USAGE OF PCBs SUMMARY OVER 1972–75

Table 1.2-1

Estimates of Cumulative PCBs Production, Usage, and Gross Environmental Distribution in the United States Over the Period 1930-1975 in Millions of Pounds

	Commercial Production	Commercial Sales	Industrial Purchases of PCB	PCBs Currently in Service	PCBs Currently in Environment	PCBs Destroyed	Estimated Reliability of Values
U.S. PCB Production	1,400						+ 5% - 20%
Total U.S. PCB Imports	3						± 30%
U.S. PCB Domestic Usage		1,253					+ 5% - 20%
Total U.S. PCB Exports		150					± 20%
PCB by Use Category:							
Petroleum Additives			1				± 50%
Heat Transfer			20				± 10%
Misc. Industrial			27				± 15%
Carbonless Copy Paper			45				± 5%
Hydraulics and Lubricants			80				± 10%
Other Plasticizer Uses			115				± 15%
Capacitors			630	450			± 20%
Transformers			335	300			± 20%
Uses Other than Electrical				8			± 60%
PCB Degraded or Incinerated:							
Environmentally Degraded						30	± 70%
Incinerated						25	± 10%
Landfills and PCBs in Dumps:							
Cap. and Trans. Production Wastes					110		± 20%
Obsolete Ele. Equipment					80		± 40%
Other (paper, plastic, etc.)					100		± 40%
Free PCBs in the Environment (soil, water, air, sediment)					150		± 30%
Total	1,403	1,403	1,253	758	440	55	

much over 1.45 billion pounds nor less than 1.1 billion pounds, based on analysis of other available or estimated data; hence, the estimated confidence interval for this value on Table 1.2-1 of +5 per cent and -20 per cent.

One of the more important conclusions from this work is the estimation of about two times the amount of PCBs in landfills and dumps as compared to the amount of PCBs already free in the environment. The material in land disposal sites may be considered a threat to become widely dispersed over a long period of time. The length of time required can only be guessed at, but is probably short in comparison to the time required for degradation of the PCBs by natural processes. Thus, release of the land disposal material through slow vaporization and leaching could very well worsen an already severe environmental problem.

1.3 Current Distribution of PCBs Usage and Associated Wastes

A material balance for PCBs production, sales, distribution, and wastes in 1974 is presented in Table 1.3-1. Reliability of the values were estimated as for the previous table. The amounts estimated to be land disposed, totaling 1.18 million pounds, do not include land disposal of previously used PCBs. However, the amounts listed under scrap PCBs incinerated account for all PCBs incineration in the U.S. during 1974 at the recommended temperature-time conditions (> 2000°F; > 1.5 seconds residence time). Of the total of 2.61 million pounds incinerated, the Monsanto facility accounted for over half. Other companies currently providing incineration services include General Electric, Rollins Environmental Services, and Chem-Trol Pollution Services, but the total number of such facilities known to be available in the U.S. is six.

1.4 Land Disposal and Environmental Load

The 1.18 million pounds per year of land-destined wastes estimated above is only a small portion of the total PCBs entering landfills and dumps yearly; the current estimated yearly rate of PCBs entering land disposal sites is about 12 million pounds. The largest source of this material is capacitors which have failed or become obsolete, or which are contained in obsolete equipment. Other important sources are industrial solid wastes from PCBs production and first-tier usage, and the total of other (non-electrical) municipal and industrial solid wastes.

Table 1.3-1

Estimated Production, Usage, and Losses of PCBs in the United States during 1974 in Millions of Pounds

	Production or Imports	Commercial Sales	Industrial Purchases by Category	Amount Disposed or Lost	Estimated Reliability of Values
Domestic Production	40.466*				± 10%
Total Imports	0.45				± 50%
Monsanto Domestic Sales		34.406*			± 10%
Exports		5.395*			± 10%
Import Sales		0.45			± 50%
From Mfg. Inventory, etc.		0.665*			± 10%
PCBs Usage by Product Category					
Capacitors			22.0		± 20%
Transformers			12.0		± 20%
Investment Casting Wax			0.4		± 20%
Other			0.05		± 70%
PCBs Disposal to Land (assume PCBs to be 30% of total solid wastes)					
From PCBs manufacture				0.03	± 50%
From capacitor industry				0.48	± 50%
From transformer industry				0.27	± 50%
From investment casting				0.4	± 30%
Incineration of Scrap PCBs					
From PCBs manufacture				0.52	± 15%
From capacitor industry				1.45	± 20%
From transformer industry				0.64	± 20%
Industrial Discharges to Water and Sewers (as PCBs)					
From PCBs manufacture				0.0011**	± 40%
From capacitor industry				0.0021**	± 60%
From transformer industry				0.0001**	± 60%
Spills during Transport				0.01	± 50%
Totals	40.916	40.916	35.45	3.80	

* From Monsanto data

** Developed from data supplied by industry. Most analyses for PCBs concentrations in industrial wastewaters are probably not more accurate than ± 50 per cent.

The total current environmental load of "Free" PCBs was estimated to be about 150 million pounds. An analysis of environment load (Free PCBs) average chlorine content per molecule indicated that, if mono-, di-, and trichloro isomers were disregarded, the average chlorine content of Free PCBs would be within seven per cent of the value for Aroclor 1254.

1.5 Foreign Production of PCBs

Known current producers of PCBs besides the United States include the United Kingdom, Czechoslovakia, France, Germany, Spain, and the U.S.S.R. Japan was a producer until 1972. In 1973, total foreign production of PCBs is estimated at 43 million pounds, corresponding to a 50 per cent reduction since 1971. On this basis, the U.S. production appears to be about half of the world total. Usage of PCBs in all countries is expected to decrease further as a result of recent findings on adverse environmental effects and potential human health hazards from PCBs, and this usage is expected to be essentially confined to use in capacitors and transformers.

2.0 CHARACTERIZATION OF INDUSTRY PRACTICE AND WASTE HANDLING FOR THE PCBs PRODUCER AND MAJOR FIRST-TIER USERS

2.1 Manufacture of PCBs and PCB-Containing Capacitors and Transformers

PCBs are produced domestically only by Monsanto at Sauget, Illinois. The process involves the batch chlorination of biphenyl and subsequent separation and purification of the desired chlorinated biphenyl fractions. The degree of chlorination is determined by the contact time in the reactor. Depending on the distance and size of shipment, transport is via tank car, tank truck, or common carrier (drums).

There are 17 capacitor plants and 18 transformer plants utilizing PCBs in the United States. Manufacture of both types of units involves initial preparation of internal and external cases, filling with PCBs under vacuum, cleaning and degreasing, and performance testing. The greatest PCB wastes occur in the filling operations. Filling of small capacitors (less than 2 pounds of PCBs) and most large capacitors is performed in chambers holding many small capacitors or fewer large ones. The chamber and the capacitors are evacuated and then flood-filled with the PCB liquid. Excess liquid is removed from the chamber, the filled units are cleaned and sealed, and then the sealed units are degreased, painted, and tested. Transformers and the largest types of capacitors are filled individually after evacuation; this produces relatively less chance of PCBs loss than the flood-filling process.

Of the 38 plants in the above categories, 10 discharge their effluents into the water ways while the remainder discharge into the sewage treatment plants. All plants in these categories have discharges under heavy rainfall conditions. There are three types of waste materials generated at these plants that require treatment and proper handling in order to minimize the PCB into the environment. These are:

(a) Waste waters containing trace quantities of PCBs (10 to 500 ppb PCBs);
(b) Waste PCBs, scrap oils and small quantities of process water highly contaminated with PCBs; and
(c) Burnable and non-burnable solid materials contaminated with PCBs.

Quantitative estimates of these wastes are given below:

	Waste Loads, Daily Average		
	PCB Discharge in Waterways or Sewers	Land-Destined PCB Wastes	Scrap Oils to Incineration
PCB Manufacturer	3.06 lbs	301 lbs	1425 lbs
Capacitor Industries	5.86 lbs	4440 lbs	3968 lbs
Transformer Industries	0.17 lbs	Unknown	1750 lbs

The above waste loads represent current industrial practice. It may be assumed that, prior to knowledge of the adverse environmental effects of PCBs, much of the types of material currently landfilled or incinerated was not disposed of properly and thus entered the environment directly.

As yet, very little is being done at these plants to control air emissions. The general industry assumption is that the vapor pressure of PCBs is so low that there will be essentially no air contamination. A few facilities, however, were reported to be filtering and chilling exhaust air from PCBs impregnation areas, and plant personnel are beginning to realize that evaporation of PCBs may make a significant contribution to general contamination of the plant area.

Since most water used at these facilities is for non-contact cooling purposes, at most plants it is possible to significantly reduce the effluent volume by segregation of wastewaters, recycling and proper housekeeping measures. Most user plants and the PCB producing plants have already undertaken PCBs containment programs in order to minimize the entry of PCBs into the environment. While the emissions of PCBs to water are expected to decrease due to improved pollution abatement of waterborne wastes, the release of PCBs to air and land may increase. One potential source of increasing air emissions is the increase in incineration due to proper handling of wastes which were previously discharged into the waterways or sewers. The quantities of land-destined wastes are expected to increase due to improved housekeeping measures.

Rivers receiving PCBs discharges for a number of years vary greatly in PCBs content with time, apparently depending upon PCB content in storm water runoff and the degree to which contaminated bottom sediments are agitated and suspended. Whereever there have been PCB operations in the past, there are probably high concentrations in local waterways bottom sediments.

Over the past 45 years, waste PCBs from transformer and capacitor operations have been used as local road oiling compounds. Sometimes they were discarded in dumps adjacent to manufacturing facilities. These are sources of long term leaching of PCBs into waterways, particularly with storm water runoff.

2.2 Treatment and Disposal of Industrial Wastes Containing PCBs

A study was performed to determine and compare the methods available for the treatment of PCB-containing wastes from the PCBs production, capacitor manufacturing, and transformer manufacturing industry categories. A full treatment of this technology, including cost estimates for treatment, may be found in the Task II Report under Contract 68-01-3259. Much of the technical portion of this work is reproduced herein and summarized below.

2.2.1 Incineration

The most advanced treatment technology in use is incineration. The PCBs manufacturer and one user have plant scale facilities capable of destroying PCBs with very high efficiency. There are at least two commercial services available, with four incinerator locations in the Eastern and Southern U.S., for PCBs incineration.

Incineration is primarily applicable to waste PCBs and scrap oils contaminated with PCBs. Incinerators for PCBs destruction have the capacity of "burning" some contaminated wastewater but, of course, the proportion of that water to the exothermic oil burning must be kept low. Only one commercial incineration service (Rollins) can routinely handle all kinds of PCBs contaminated transformer and capacitor components, sludges, fuller's earth and other solids, as long as they can be contained in a 47 gallon fiber drum. One PCB user company incinerates transformer internals for purposes of metal recovery.

Waste liquid PCBs and scrap oils (contaminated PCBs) are best handled, as a guideline, by high temperature (2000-2400°F) and long residence time (2-3 seconds) incineration. However, because of incinerator design variables, the conditions should be chosen in each case to lead to 99.999% destruction. The best incinerator combination for handling wastes from these industries is a rotary burner fired by a liquid burner, and followed by an afterburner and scrubber system for HCl and particulate control. The rotary burner can be designed to handle a variety of solid materials, and the liquid burner can handle both the oily and water type wastes.

2.2.2 Treatment of PCB-Contaminated Wastewater

There is no commercial scale wastewater treatment for PCBs removal being practiced beyond those of gravity settling of the heavy PCBs layers as a sludge from the bottom of sumps or tanks, and skimming of a contaminated oil-layer from the water surfaces.

Adequate methodology is available for those plants wishing to control the release of PCBs to the environment. Currently available technologies can be applied to the efficient removal of PCBs from wastes, or their destruction with the other wastes. The PCBs content of wastewaters can be lowered to the 1 ppb level or below by removal of solids (and oil layers, where applicable), followed by adsorption of PCBs onto carbon, macroreticular polymer resins or possibly other adsorbents.

Carbon adsorption is currently the best available technology for plant scale treatment of PCBs wastewaters. This conclusion is based on laboratory tests with PCBs in water, and on the long background of plant scale use of carbon adsorption for removal of organics from water.

Polymeric resins (AMBERLITES) were found in laboratory tests to be approximately as effective as carbon in removing PCBs from water. Further pilot scale testing is needed with this newer (than carbon) technology to accurately assess its potential.

Ultraviolet catalyzed ozonation was determined to be the best method, demonstrated on a laboratory scale, for destruction of PCBs in wastewaters when the streams occur in large volume, on a relatively continuous flow basis and with PCBs at the ppb concentration levels. This technology has the potential for conversion of PCBs to CO_2, H_2O and HCl. However, significant development and optimization work would be required before application of the process becomes practical. In addition, the potential exists for production of toxic degradation products by UV-ozonation.

Although still in the laboratory stage, catalytic reduction of PCBs offers the possibility of reduction to biphenyl and HCl; and catalytic oxidation is another process which offers a potential for destruction of PCBs to CO_2, H_2O and HCl.

It is believed that wastewater treatment systems employing activated carbon and possibly UV-ozonation could produce effluents which would be at or below the limits of detectability for PCBs with current analytical techniques. However, since no full scale systems for the treatment of PCBs are in operation at this time, this possibility cannot be confirmed.

SECTION V

INDUSTRIAL CHARACTERIZATIONS

1.0 INTRODUCTION

This section discusses polychlorinated biphenyls (PCBs) production and each PCBs user (capacitor, transformer, investment casting, paper recycling and miscellaneous) manufacturing process. When known, for each operation the following information is given:

- Name and the location of companies in each category;
- A description of the processes at the facilities studied and pertinent flow diagrams, where appropriate;
- Raw waste load data per ton of PCB used and sources of these wastes;
- Water usage data in terms of gallons per day;
- Treatment and housekeeping measures practiced at the facilities and on-going PCB containment programs;
- Plant waste effluents found and their composition.

2.0 MANUFACTURING PROCESS - POLYCHLORINATED BIPHENYLS (PCBs)

2.1 Process Description

Monsanto, the sole domestic manufacturer of PCBs, manufactures this chemical in their Sauget, Illinois plant. The basic raw material is biphenyl which is manufactured from pure benzene in another Monsanto plant. The PCB manufacturing operation is conducted in two steps. First, biphenyl is chlorinated with anhydrous chlorine in the presence of ferric chloride to produce crude PCBs and then the crude PCBs are distilled to obtain the finished product. A schematic flow diagram of this process is given in Figure 2.1-1A and B.

FIGURE 2.1-1A. PREPARATION OF CRUDE CHLORINATED BIPHENYLS-MONSANTO KRUMMRICH PLANT

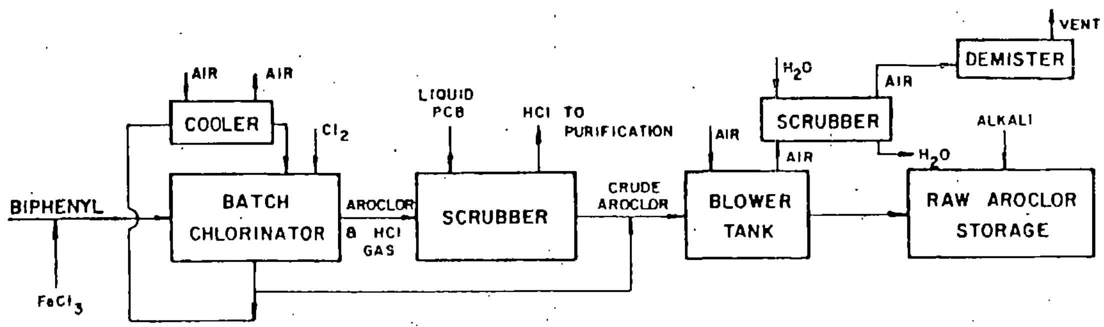
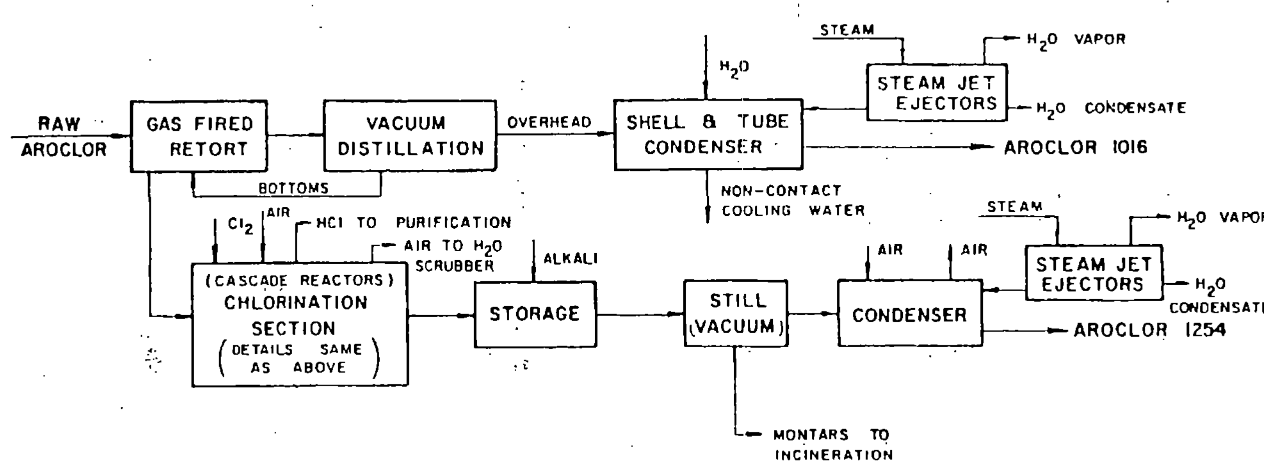


FIGURE 2.1-1B. DISTILLATION OF CRUDE PRODUCTS-MONSANTO KRUMMRICH PLANT



The reaction section consists of 6 reactors (3 batch and 3 cascade). Currently, Monsanto manufactures four different types of Aroclors (1242, 1016, 1254 and 1221). For the manufacture of any given product, the chlorinator is charged with proper quantities of biphenyl and catalyst and heated above the melting point of biphenyl. The flow of vaporized chlorine is then started and the charge is circulated with a pump. Throughout the chlorination, the temperature is kept above the melting point of the mixture, but below 150°C to avoid excessive sublimation and plugging of the line discharging the hydrogen chlorine produced by the chlorination. The reaction pressure is maintained near atmospheric. The degree of chlorination is principally determined by the time of contact with anhydrous chlorine. The contact time varies from 12 to 36 hours for the manufacture of different Aroclor types. The degree of chlorination is measured by the specific gravity of the mixture or the ball and ring softening point when the product is viscous.

The vapors from the chlorinator (HCl containing PCBs) are scrubbed with liquid Aroclor and the gaseous HCl is sent to another plant at the Sauget complex for purification. The crude product is held at an elevated temperature and blown with dry air for several hours, after which it is sent to the raw Aroclor storage tank where a few tenths of 1 percent of alkali are stirred with the material to react with any remaining hydrogen chloride or ferric chloride. The air from the blower tank is scrubbed with water and vented to the atmosphere through a demister.

The raw Aroclor is subsequently batch distilled under reduced pressure to remove the color, and the traces of hydrogen chloride and ferric chloride. The methods of purification are different for the different types of end products. Raw Aroclor 1254, 1242 and 1221, each are distilled in stills under reduced pressure, achieved via steam jet ejectors; the condensate from the still is the finished product while the bottoms are the Montars which are drummed and sent to incineration.

The distillation section for the 1016 product consists of a gas fired retort and a vacuum distillation tower. The latter is used to allow the separation of the higher chlorinated, less biodegradable compounds from the relatively lower chlorinated and more biodegradable ones. The raw Aroclor (42% chlorinated material) is fed into the reboiler. The vacuum in the tower is maintained at about 100 mm Hg by steam jet ejectors. The steam is partially condensed and the condensate is discharged into the plant discharge sump. The first cut from this tower is recycled back to the retort. At a preset overhead temperature the 1016 product is collected and sent to the product storage. The high boiling residue from the tower is sent to a subsequent chlorination cycle and the resulting raw Aroclor is distilled in a still. The overhead from this still is the finished product. The bottoms from this tower are the Montars. The spent ferric chloride catalyst, used in PCB manufacturing, is sent to incineration with Montar residues.

For special orders, in order to increase electrical resistivity, the Aroclors are stirred at an elevated temperature with a few tenths of 1% of well-dried fuller's earth and then filtered through paper.

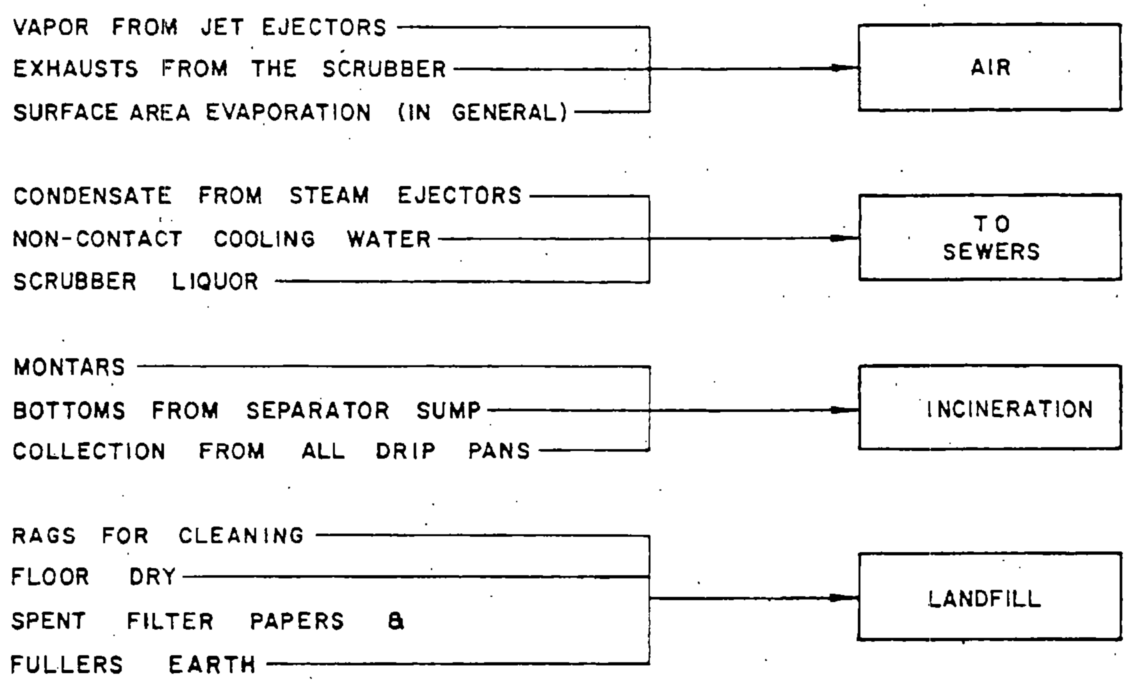
All Aroclors are stored at 150°F. Steam coils are used on the storage tanks for heating these tanks.

2.2 Raw Wastes

The raw wastes from the manufacturing area consist of the liquor from the scrubber, the condensate from the steam jet ejectors, water used for showers and eye baths, miscellaneous floor wash downs, waste oil collected in drip pans and drums, and montars which are the bottom cut from their stills. The composition and the quantities of the individual waste stream are not monitored. All effluent streams generated in the manufacturing area are directed into the sumps in this area. The waste oil collected in the drip pans and the Montars are emptied into 55 gallon drums and sent to incineration.

The raw wastes generated in the incinerator consist of the venturi scrubber liquor and the water phase from the separator sump in the incinerator area. The composition of the combined stream is monitored. However, the composition of the individual streams is not known. Non-product PCB discharges are shown in Figure 2.2-1. It has been estimated that this plant generates

FIGURE 2.2-1. NON-PRODUCT PCB DISCHARGES AT MONSANTO'S KRUMMRICH PLANT



about 25 lbs of scrap oil and Montar per ton of PCB produced. Additionally, the quantities of material sent to landfill approximates to 5.4 lbs per ton of PCB produced. Further, Monsanto reports that the plant's PCB contribution to the air is under 1 lb/day.

2.3 Plant Water Usage

On the average, the PCB plant uses a maximum of 388,800 gallons of water and a maximum of 360,000 lbs of steam daily. Water is used for non-contact cooling purposes in shell and tube condensers, in a water scrubber, for floor washings, for showers and in eye baths. Steam is used in the steam jet ejectors and for steam tracing purposes. The plant uses municipal water and purchased steam.

The process water from this facility consists of the liquor from their scrubber and the steam condensates which are discharged in one of the two sumps in the manufacturing area.

Additionally, 273,600 gallons of water are used in the incinerator daily for quenching the hot gases from the fire box. The resulting weak muriatic acid in the quench pot is used in the venturi scrubber and in the packed tower.

The type and quantities of water used and discharged at this plant are summarized below:

Water Balance

. Manufacturing Plant

	Quantities, GPD	
	Used	Discharged
Process Water		
in water scrubber	14,400	14,400
misc. floor wash downs	7,200	7,200
condensate from steam jet ejectors	--	14,400

Water Balance (Con't)

. Manufacturing Plant

		Quantities, GPD	
		Used	Discharged
Non contact cooling water		360,000	360,000
showers, eye bath		7,200	7,200
condensate from steam tracers		--	28,800
	Total	388,800	432,000

. Incinerator

water used for hot gas quenching		273,600	273,600
water phase from the sump		--	14,400
	Total	273,600	288,000

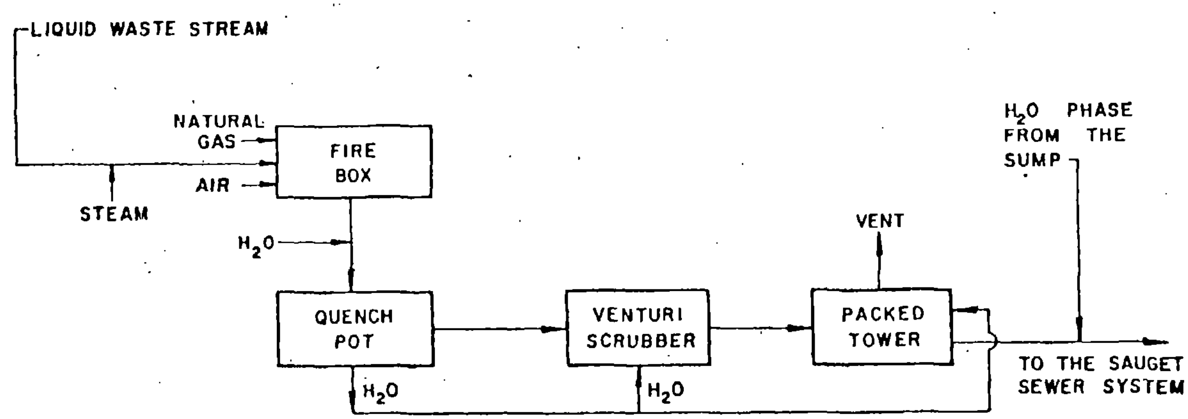
2.4 Wastewater Treatment and Housekeeping

Monsanto reports significant environmental controls at their Krummrich, Sauget plant. Since 1969, they have invested more than 22 man-years of work and millions of dollars in this program. The in-house goals have reduced the PCB discharges into water to about three pounds per day.

A John Zink designed incinerator was erected at Sauget in 1970 to safely dispose of PCBs. A schematic flow diagram of this operation is given in Figure 2.4-1. Aroclor is steam atomized and fed into the fire box. Natural gas is used for combustion and the feed is incinerated at temperature above 2200°F at 5 percent excess oxygen with a retention time of 2-3 seconds. The gases are quenched with water and the exhausts from the quench pot are passed through a high-energy venturi scrubber, then through a packed column which is irrigated by the weak muriatic acid originating from the quench pot. Exhausts are then vented to atmosphere through a demister. These exhausts as well as the effluent from the incinerator section are monitored.

In the incineration area, drainage is directed to trenches and piping which flow into a 10,000 gallon underground concrete basin. The water

FIGURE 2.4-1. PROCESS FLOW DIAGRAM OF THE JOHN ZINK INCINERATOR AT MONSANTO'S KRUMMRICH PLANT



layer from this basin is pumped continuously, combined with the scrubber liquor, metered, monitored and discharged into the sanitary sewers of the Sauget complex and from there it is sent to the East St. Louis municipal sewers. The organic phase from the sump is periodically pumped into waste storage tanks for incineration.

The incineration unit has a rated design capacity of 10 million pounds per year. However, since the start of its operation this unit has achieved a service factor of about 0.60. Monsanto reports that this incinerator can achieve a maximum of 6 million pounds of capacity annually; the unit is plagued with various mechanical problems.

Monsanto uses their incinerator to process both their own wastes and as a service to other industries. The service charge for incineration is an average of 5¢ per lb of material, but the cost appears to be increasing.

The incinerator feed is brought into the plant either by truck in 55 gallon sealed drums, by tank trucks or by rail. The drums are opened, picked up by a fork lift and emptied into a concrete pit. The tank truck carrying the waste liquids enters the incinerator area and the liquid waste is then pumped from the truck into the pit. The material in this pit is periodically pumped via a vertical certrifugal pump into one of the four 20,000 gallon incinerator waste feed tanks.

The rail car is brought into a designated area close to the incinerator site. The material from the rail car is normally pumped into a long term, 500,000 gallon storage tank. The material from this tank is pumped into the incinerator feed tanks located on the incinerator pad when required.

Drainage is provided along the rail tracks. These drains empty into the 10,000 gallon sump located under the incinerator pad.

In the manufacturing area, Monsanto has taken a number of significant steps to prevent loss of PCBs to the environment. Drainage is directed to trenches and piping, and then to one of two concrete 3,000-gallon underground settling basins. This insures PCB containment in case of accidental spill or equipment failure. Relief valve lines and atmospheric vents are routed through catch tanks, or are redirected to settling basins.

When small quantities of PCBs are collected in the settling basins of the manufacturing area they are later pumped into 55 gallon drums, and eventually incinerated. The overflow from these sumps is combined with the non-contact cooling water used at the plant, monitored and then discharged into the Sauget complex's sanitary sewer and from there to the East St. Louis municipal system.

PCBs are packed and shipped in galvanized-steel 55 gallon drums, or in railroad tank cars. All tank cars are top loaded. In the drum filling area spills are cleaned via rags or floor dry and these materials are drummed and sent to landfill located in the town of Sauget.

In the PCB truck or rail car loading area, drainage is directed into a small concrete pit. The material accumulated in this pit is periodically pumped into the basins located in the manufacturing area.

Nitrogen blanketing is provided on storage tanks to eliminate any "breathing" of the tanks and resultant PCB escape.

Mist eliminators have been installed in vapor lines to eliminate the possibility of PCBs leaving the manufacturing area through these lines.

Finally, underground sewers have been replaced with above-ground sewers, and repaired or combined with others, so that the effluent from the department can be monitored. In addition, this step will prevent any unknown buildup of PCBs in the sewer systems or any contamination of PCBs into other sewers.

A high housekeeping level is maintained in the plant itself. Housekeeping responsibilities which the operators have assumed are as follows:

- <u>All</u> pumps are checked for leakage on every shift. Drip pans that collect leaks are emptied into scrap PCB drums.

- All leaks are reported and documented so that corrections can be made and settling basins observed.

- "Floor Dry" is used to absorb any PCBs that have spilled or leaked. If it becomes necessary to flush PCBs to the settling basin, a minimum amount of water is used.

- Sampling drums and scrap PCB drums are quickly palletized, labelled and transferred to the incineration area.

2.4.1 Treatment Facility for the Effluent from Sauget Complex

The processing and incineration departments' aqueous effluent enters the plant sewer system, and this system discharges into the Sauget Village waste sewer system. The combined streams then flow to the village primary treatment plant. The village treatment plant is under expansion to a secondary chemical treatment plant, scheduled for 1976 completion.

Additionally, evaluations are being conducted to include the village plant discharge in a projected regional biological treatment plant.

2.5 Plant Effluents

This plant has no point source discharge from their operation. There is a single discharge from the manufacturing operation (the combined stream of process and non-contact cooling water) to the main sewer system of the Sauget complex and there is a second discharge from the incinerator area to the same sewer system. The composition of these streams as reported by Monsanto are as follows:

	Effluent from the Manufacturing Operation	Effluent from the Incineration area
flow rate, gpd	432,000	288,000
PCBs, ppm	0.75	0.15
PCBs, lbs/day	2.70	0.36

SECTION VII

PRODUCTION AND DISTRIBUTION

1.0 PRODUCTION AND CURRENT USE

1.1 Domestic Production of PCBs and PCTs

Currently there is only one known commercial scale PCB production installation in the U.S., the William G. Krummrich plant of the Monsanto Chemical Company in Sauget, Illinois. This facility is specifically designed for chlorobiphenyls production and has a design capacity of 48 million pounds per year.

Until 1971 PCBs were also manufactured at Monsanto's Anniston, Alabama plant which had a design capacity approximately equal to the Sauget plant. The Alabama operation was discontinued and the plant dismantled in 1971.

PCBs manufactured by Monsanto are marketed under trade name "Aroclor". Tables 1.1-1 and 1.1-2 present data from Monsanto related to production and sales of PCBs from 1957-1974 and production of polychlorinated terphenyls (PCTs) from 1959-1972. The production of PCTs were terminated in 1972. Until then in addition to PCBs (Aroclor series 12) Monsanto manufactured Aroclors 2565, 4465, 5442 and 5460. Aroclors 2565 and 4465 were blends of PCBs and PCTs and Aroclors 5442 and 5460 were two different grades of PCTs. Also given in these Tables are breakdowns of domestic sales per use category and by PCB grade. Detailed information and breakdown on PCB/PCT blends and PCT grades is not available. However, Monsanto reports that the predominant material produced was Aroclor 5460. When produced and marketed these materials were used in plasticizer applications. Figures 1.1-1 through 1.1-3 are graphical representations of these data.

As can be seen from Figure 1.1-1, the majority of the PCBs produced in the United States was marketed domestically. Production and sales of PCBs in 1974 were less than half of those for 1970, where production and sales of PCBs were at their maximum. The difference between production and sales on

TABLE 1.1-1

PCB & PCT MANUFACTURE AND PCB SALES

MONSANTO INDUSTRIAL CHEMICALS COMPANY

1957 thru 1964
(Thousands of Pounds)

	1957	1958	1959	1960	1961	1962	1963	1964
U.S. PRODUCTION OF PCBs	(1)	(1)	(1)	37919	36515	38353	44734	50833
DOMESTIC SALES OF PCBs	32299	26061	31310	35214	37538	38043	38132	44869
U.S. EXPORT SALES OF PCBs	(2)	(2)	(2)	(2)	(2)	(2)	3647	4096
U.S. PRODUCTION OF PCTs	-	-	2996	3850	2322	4468	4920	5288
DOMESTIC SALES OF PCBs BY CATEGORY								
Heat Transfer	-	-	-	-	-	157	582	929
Hydraulics/Lubricants	1612	1549	2685	2523	4110	3915	3945	4374
Misc. Industrial	704	755	1569	1559	2114	1681	1528	1692
Transformer	12955	5719	5984	7921	6281	7984	7290	7997
Capacitor	17028	14099	16499	16967	15935	15382	15606	19540
Plasticizer Applications	(1)	3939	4573	6244	9098	8924	9181	10337
Petroleum Additives	-	-	-	-	-	-	-	-
DOMESTIC SALES BY PCB GRADE								
Aroclor 1221	23	16	254	103	94	140	361	596
Aroclor 1232	196	113	240	155	241	224	13	13
Aroclor 1242	18222	10444	13598	18196	19827	20654	18510	23571
Aroclor 1248	1779	2559	3384	2827	4023	3463	5013	5238
Aroclor 1254	4461	6691	6754	6088	6294	6325	5911	6280
Aroclor 1260	7587	5982	6619	7330	6540	6595	7626	8535
Aroclor 1262	31	184	359	326	361	432	414	446
Aroclor 1268	-	72	102	189	158	210	284	190
Aroclor 1016	-	-	-	-	-	-	-	-

(1) Production figures and Plasticizer Applications figures unavailable during year indicated.
(2) U.S. Export Sales figures unavailable during year indicated.

TABLE 1.1-2

PCB & PCT MANUFACTURE AND PCB SALES

MONSANTO INDUSTRIAL CHEMICALS COMPANY

1965 thru 1974
(Thousands of Pounds)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
U.S. PRODUCTION OF PCBs	60480	65849	75309	82854	76389	85054	34994	38600	42178	40466
DOMESTIC SALES OF PCBs	51796	59078	62466	65116	67194	73061	34301	26408	37742	34406
U.S. EXPORT SALES OF PCBs	4234	6852	8124	11231	10624	13651	-	6388	8346	5395
U.S. PRODUCTION OF PCTs	6470	8190	9450	8870	11600	17768	20212	8134	-	-
DOMESTIC SALES OF PCBs BY CATEGORY										
Heat Transfer	1237	1766	2262	2529	3050	3958	3060	752		
Hydraulics/Lubricants	4616	4258	4643	5765	8039	7403	1552	0		
Misc. Industrial	1841	1779	1426	1283	1079	1627	1155	0		
Transformer	8657	8910	11071	11585	12105	13828	11134	25656	37742	34406
Capacitor	23749	28884	29703	29550	25022	26708	14141			
Plasticizer Applications	11696	13481	13361	14404	16460	19537	3259	0		
Petroleum Additives	-	-	-	-	1439	-	-	0		
DOMESTIC SALES BY PCB GRADE										
Aroclor 1221	369	528	442	136	507	1476	2215	171	35	57
Aroclor 1232	7	16	25	90	273	260	171	0	0	0
Aroclor 1242	31533	39557	43055	44853	45491	48588	21981	728	6200	6207
Aroclor 1248	5565	5015	4704	4894	5650	4073	213	807	0	0
Aroclor 1254	7737	7035	6696	8891	9822	12421	4661	3495	7976	6185
Aroclor 1260	5831	5875	6417	5252	4439	4890	1725	305	0	0
Aroclor 1262	558	768	840	720	712	1023	1	0	0	0
Aroclor 1268	196	284	287	280	300	330	0	0	0	0
Aroclor 1016	0	0	0	0	0	0	3334	20902	23531	21955

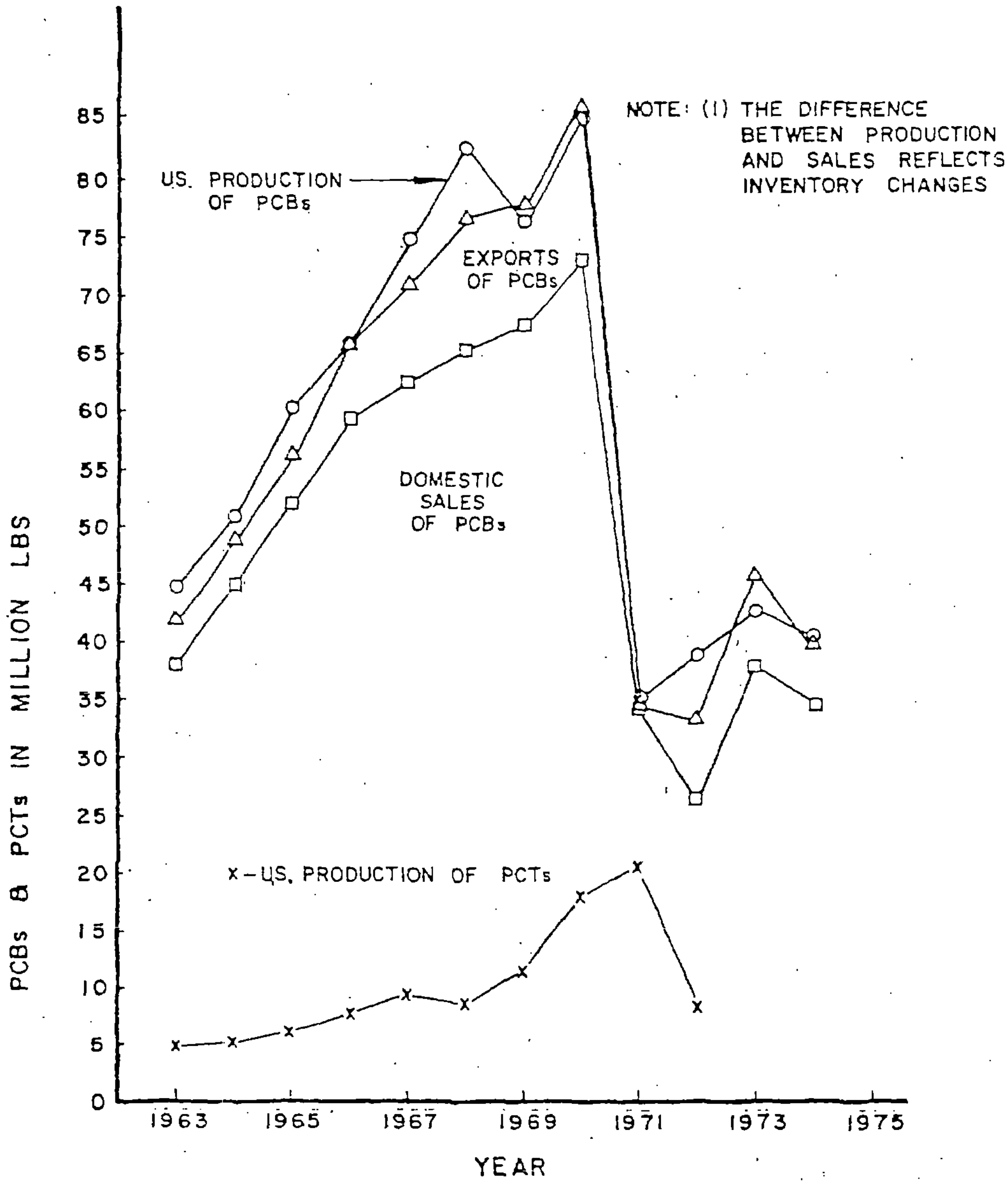


Figure 1.1-1 - U.S. Production of PCBs and PCTs and Domestic Sales and Exports of PCBs

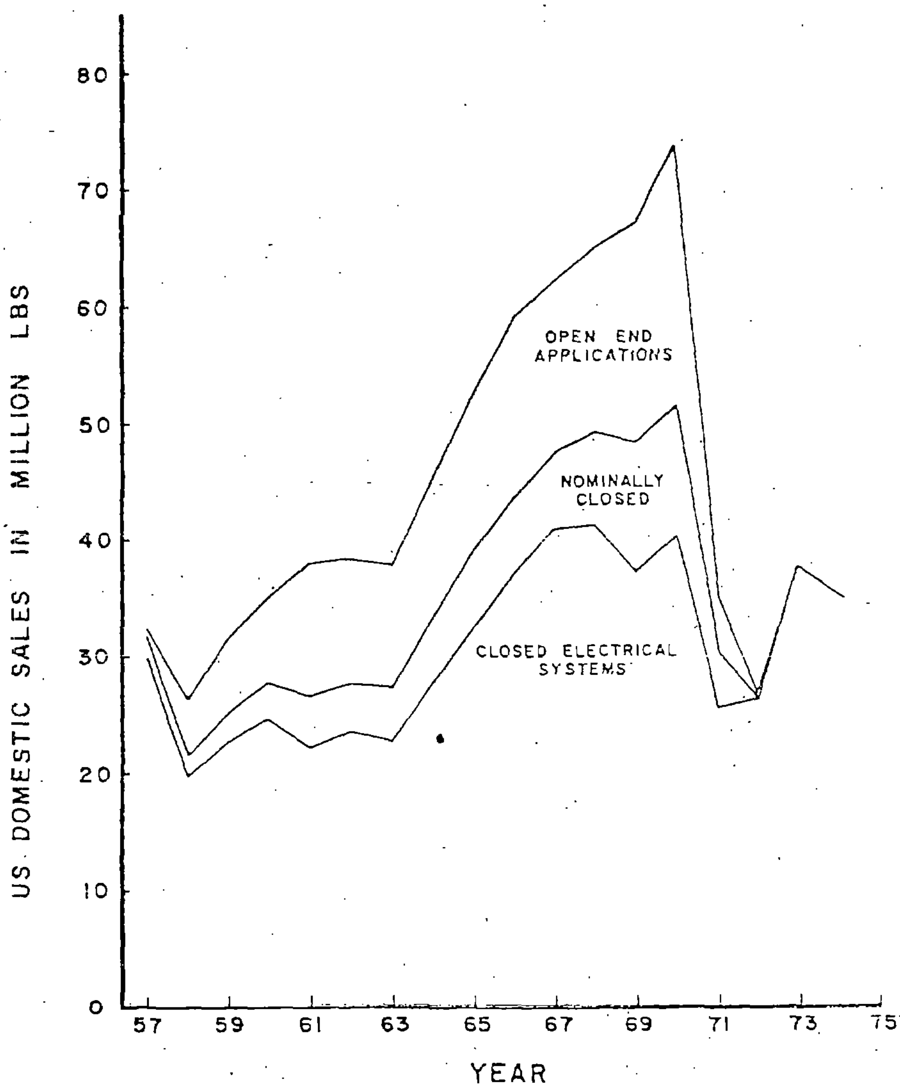


Figure 1.1-2 - U.S. Domestic Sales of PCBs by End Use Applications

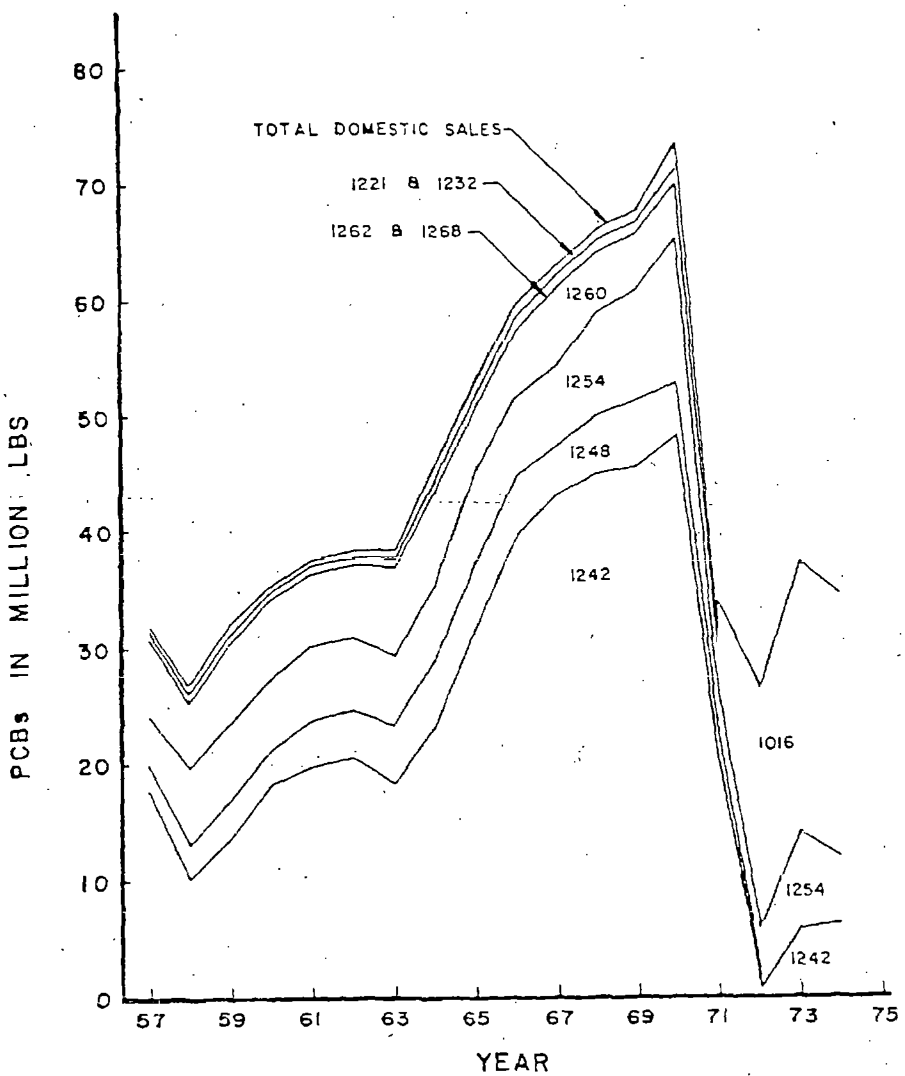


Figure 1.1-3 - U.S. Domestic Sales of PCBs by Type

this graph reflects inventory changes of PCBs. Figure 1.1-1 also indicates that the production of PCTs increased steadily through 1971 when their production was at the maximum. The production of PCTs was terminated in 1972.

Table 1.1-3 shows production, sales and export of PCBs for the first quarter of 1975. Monsanto reports that sales for Aroclor are expected to increase at an average annual rate of 6-7 percent over the next few years. Additionally, exports of Aroclor are expected to maintain the same ratio to the U.S. production as in the past.

Figure 1.1-2 indicates that prior to Monsanto's voluntary restriction of sales to all applications with the exception of "closed electric systems", approximately 13 percent of the PCBs in the U.S. was used in "nominally closed" applications (heat transfer, hydraulic fluids and lubricants) and 26 percent was used in "Open End" applications (plasticizers, surface coating, ink, adhesives, pesticide extenders, and microencapsulation of dyes for carbonless duplicating paper) where entries of PCBs to the environment are more probable and PCB emissions are uncontrollable. At present, almost all domestic production is being used in "closed electric systems" (transformer and capacitor applications) where PCB emissions are more controllable.

Between 1957 and 1971 there were twelve different types of Aroclor manufactured by Monsanto with chlorine contents ranging from 21 to 68 percent. Aroclor 1242 and grades lower than 42 percent chlorine made about 48 percent of the total production consumed. U.S. Sale of Aroclor 1242 has dropped drastically since 1971 and has been replaced by Aroclor 1016. Sales of Aroclor 1254 remained about the same for the period 1957 - 1974. Currently, there are four different types of Aroclor manufactured by the Monsanto Company-Aroclors 1221 and 1016 for capacitor applications and Aroclors 1242 and 1254 for transformer applications.

Past and current end-use of PCBs by types are presented in Table 1.1-4. In the years prior to 1971 the largest "open-end" use of PCBs and PCTs has been in plasticizer applications. According to Monsanto, a large percentage of the production of Aroclor 1242 and lower chlorine content grades and the entire PCT production were used for this application. Following Monsanto's

TABLE 1.1-3

PCB MANUFACTURE AND SALES
MONSANTO INDUSTRIAL CHEMICALS COMPANY
First Quarter - 1975

	(Thousands of Pounds)
U.S. PRODUCTION	8532
DOMESTIC SALES	7986
U.S. EXPORT SALES	1538
DOMESTIC SALES	
Transformer and Capacitor	7986
DOMESTIC SALES BY PCB GRADE	
Aroclor 1221	10
Aroclor 1242	2201
Aroclor 1254	2115
Aroclor 1016	3660

PREDOMINANT UTILIZATION OF AROCLORS

Aroclor 1221, Aroclor 1016	Capacitors
Aroclor 1242, Aroclor 1254	Transformers

TABLE 1.1-4

END-USES OF PCTs AND PCBs BY TYPE

End-Use	1016	1221	1232	1242	1248	1254	1260	1262	1268	PCTs
Existing Sales										
Capacitors	XX	X		XX		X				
				through 1971						
Transformers				X		XX	X			
							through 1971			
Sales Phased-Out										
Heat transfer				X						
Hydraulics/ lubricants										
. hydraulic fluids			X	X	X	X	X			
. vacuum pumps					X	X				
. gas-transmission turbines		X		X						
Plasticizers										
. rubbers		X	X	XX	X	X			X	
. synthetic resins					X	X	X	X	X	XX
. carbonless paper				XX						
Miscellaneous Industrial										
. adhesives		X	X	XX	X	X				XX
. wax extenders				XX		X			X	XX
. dedusting agents						X	X			
. inks						X				XX
. cutting oils						X				
. pesticide extenders						X				
. sealants & caulking compounds										XX

Notes: (1) X denotes use of a given Aroclor in a specific end-use, while XX denotes principal use
(2) PCTs denote series 25, 44 & 54 Aroclors

Source: Monsanto Industrial Chemical Co.

voluntary restrictions in 1972, Aroclor sales for plasticizer applications dropped to small percentage to that of the previous years. Historically, capacitors have always been the single largest PCB use category except for the years 1969-1971 when Aroclor usage for plasticizer applications was higher. The major uses of PCBs prior to 1969 in order of volume of material used is listed below:

- Capacitors
- Plasticizers
- Transformers
- Hydraulic fluids and lubricants
- Heat transfer fluids

1.2 Foreign Production and Distribution of PCBs

Known current foreign producers of PCBs are the United Kingdom, Czechoslovakia, France, Germany, Italy, Spain and the U.S.S.R. Detailed information on total production of PCBs outside the U.S. is not available. However, total foreign production of PCBs was roughly estimated by the Interdepartmental Task Force to be 80-85 million pounds annually prior to 1971. This value included 26 million pounds produced by Japan. Foreign production of PCBs has, however, decreased primarily due to Japanese action on banning the domestic production of PCBs. In 1973 foreign production of PCBs was estimated to be 43 million pounds, accounting for a 50% reduction. Production, trade and use of PCBs by OECD member countries for the year 1973 is given in Table 1.2-1. The combined PCB output of three major European producers, France, Italy and United Kingdom was about 36 million pounds in 1973. World commerce in PCBs is expected to decrease further, due to OECD member countries' activities, and to be essentially confined to capacitor and transformer applications.

1.3 Summary of Recent PCBs and PCTs Imports

A summary of estimated imports of PCBs since 1971 is presented in Table 1.3-1. Importation of PCBs appears to be steady or increasing, and currently is in the range of one percent of the domestic sales reported by Monsanto.

Table 1.2-1 - Production, Trade and Use of PCBs
OECD Member Countries (1973)

Country	Total Production of PCBs	Total Import of PCBs	Total Export of PCBs	End of Use by Category: Transformer Application	Capacitors (large)	Capacitors (small)	Heat Transfer System	Hydraulic Equipment	Vacuum Pump	Lubricating & Cutting Oil	Plasticizers	Others
Australia												
Austria (2)	*	-										
Belgium	0	?	?	1.16	0.40	-	?	?	?	?	?	0
Canada	0	2.38	0	1.98 (3)	0.44 (4)	0.41 (4)	0	0	0	0	?	0
Denmark												
Finland	0	0.53	0	0.09 (3)	0.44 (4)	0	0	0	0	?	0	0
France	21.33	0.66	10.12	6.48	2.87		0.16	0.17	0.01	0.49	1.45	0.25
Germany (2)	*											
Greece												
Iceland												
Ireland												
Italy	5.55	3.53	2.44	2.70	3.14 (3,4)	0	0	0	0	0	0.64 (4,5)	0.16 (6,8)
Japan	0	(2)	(2)									
Luxembourg												
Netherlands	0	?	0	?	?	?	?	?	?	0	0	0
New Zealand	0	0.04 (9)	0	0.075	0	0	0	0	0.005	0	0.02	0
Norway (10)	0	0.04	0	0	0.05 (4)	0.005	0	0.	0	0	0	0
Portugal												
Spain	*											
Sweden (10)	0	0.70	0	0	0.72	0	0	0	0	0	0	0
Switzerland												
Turkey	0	0	0									
United Kingdom	8.97	0.01	6.53	0.71 (3)	←— 1.82 (9) —→							
United States	42.18	0.57	8.35	←—	37.87 (13)	—→	?	0.04	?	?	0.04 (12)	?

Notes:

(1) All quantities are in million pounds
(2) Information is not available
(3) PCB containing 54 wt % chlorine
(4) PCB containing 42 wt % chlorine
(5) PCB containing 64 wt % chlorine
(6) PCB containing 70 wt % chlorine
* indicates PCB producer country
(7) "Others" refers to PCBs were used to reseller and in research
(8) "Others" refers to PCBs used as a fire-retardant in plastics
(9) This figure includes about 6 percent from previously imported material
(10) Amount reported as import and quantities quoted in usage do not agree
(11) With regards to the use of PCBs in transformers and capacitors, definitive figures are not available
(12) Used in investment casting
(13) This figure includes 0.13 million pounds of imported material

Table 1.3-1

Preliminary Summary of PCBs Import Data for 1971-75 Versus Monsanto Production and Sales Data

	Year or Portion of Year				
	1971	1972	1973	1974	1975
Estimated Imports (lb)	550,000	700,000	480,000	450,000	450,000 (6 mos)
Monsanto Domestic Sales (lb)	34,301,000	26,408,000	37,742,000	34,406,000	7,986,000 (3 mos)
Imports as Percentage of Domestic Sales	1.6	2.7	1.3	1.3	-
Monsanto Exports (lb)	-	6,388,000	8,346,000	5,395,000	1,538,000 (3 mos)
Ratio of Exports to Imports	-	9.1	17.3	13.5	-

During 1971 and 1972 most of the PCBs imported into the United States originated in Japan, ostensibly corresponding to sales of stocks unsalable in Japan due to pending or established regulatory action. There apparently has been little or no U.S. importation of PCBs from Japan since 1972. The major importer was Marubeni America Corp., West Caldwell, N.J.

Since 1972, most of the imported PCBs originated in Italy, with a small amount imported from France (manufactured by Prodelec). This French material is similar to Aroclor 1242 and is used (40,000-60,000 lb. per year) as a coolant in mining machinery by Joy Mfg. Co., Franklin, Pa. Decachlorobiphenyl (Fenclor DK) is imported from Italy by Yates Mfg. Co., Chicago, Ill., for use in the manufacture of investment casting waxes. Estimated current usage is about 400,000 lb/year.

Polychlorotriphenyls, also used in pattern wax formulations, appear to be imported at an increasing rate. Estimated amounts are:

1973	1974	1975 (6 mos.)
160,000 lb.	330,000 lb.	200,000 lb.

Major importers of PCTs are Progil, Inc. (formerly Prochimie) and Intsel Co., both located in the New York City area. Most of the imported PCTs originate in France (Prodelec).

Use of PCBs and PCTs in casting waxes appears to be generally stable or increasing slowly, and under conditions of lack of regulatory control in the future, such use would be expected to continue at least at the current rate. On the other hand, Joy Mfg. Co. no longer manufactures mining equipment using PCBs as coolant; the amounts imported by Joy are used to service existing equipment. However, since Joy imports only 10 to 20 percent of the total, the overall imports will not be affected greatly by future decreases in imports by Joy.

2.0 FIFTEEN YEAR EXTRAPOLATIONS FOR PCB PRODUCTION AND USE IN ELECTRICAL EQUIPMENT

The subject data base was assembled from domestic sales figures for Aroclors reported by Monsanto – capacitor and transformer sales being summed