UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MARYLAND
BALTIMORE DIVISION

MAYOR AND CITY COUNCIL OF BALTIMORE
City Hall
100 North Holliday Street
Baltimore, MD 21202,

Plaintiff,

v.

MONSANTO COMPANY
c/o Corporation Service Company
251 Little Falls Drive
Wilmington, DE 19808;

CASE NO.: _____

SOLUTIA INC.
c/o Corporation Service Company
251 Little Falls Drive
Wilmington, DE 19808; and

PHARMACIA CORPORATION
c/o The Corporation Trust Company
1209 Orange Street
Wilmington, DE 19801,

Defendants.

COMPLAINT

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I. NATURE OF THE ACTION

1. Polychlorinated biphenyls (or "PCBs") are man-made chemical compounds that have become notorious as global environmental contaminants. PCBs are found in bays, oceans, rivers, streams, soil, and air. As a result, PCBs have been detected in the tissues of all living beings on earth including all forms of marine life, various animals and birds, plants and trees, and humans.

2. The extent of environmental PCB contamination is troubling because PCBs cause a variety of adverse health effects. In humans, PCB exposure is associated with cancer as well as serious non-cancer health effects, including effects on the immune system, reproductive system, nervous system, endocrine system and other health effects. In addition, PCBs destroy populations of fish, birds, and other animal life.

3. Monsanto Company was the sole manufacturer of PCBs in the United States from 1935 to 1977, and trademarked the name "Aroclor" for certain PCB compounds. Although Monsanto knew for decades that PCBs were toxic and knew that their ordinary and intended uses would result in widespread contamination of natural resources and living organisms, Monsanto concealed these facts and continued producing PCBs until Congress enacted the Toxic Substances Control Act ("TSCA"), which banned the manufacture and most uses of PCBs as of January 1, 1979.

4. PCBs were used in many industrial and commercial applications, including paint, caulking, transformers, capacitors, coolants, hydraulic fluids, plasticizers, sealants, inks, lubricants, among other uses. PCBs regularly leach, leak, off-gas, and escape their intended applications, contaminating runoff during naturally occurring storms and other rain events.

5. As a result, PCBs contaminate the streets, the drainage systems, stormwater, and water bodies within the boundaries of Baltimore. This contamination, together with costs incurred

or to be incurred in investigating, analyzing, monitoring, and remediating such contamination, constitutes injury to Plaintiff.

6. The Mayor and City Council of Baltimore, in its governmental capacity, owns and operates a municipal separate stormwater system ("MS4") that captures precipitation that falls on impervious surfaces such as streets, sidewalks, and roofs. The stormwater system includes, among other things, gutters, inlets, pipes, outfalls, catch basins, and other stormwater infrastructure and features.

7. According to State water quality data from 2016, around 921 square miles of Maryland's estuarine waters are "impaired" by PCB contamination. In addition, approximately 223 miles of Maryland's rivers and streams, and approximately 3,150 acres of Maryland's lakes and reservoirs, are similarly impaired.

8. PCB-impaired waters in Maryland—that is, waters with PCB concentrations in excess of levels determined to be safe for human beneficial uses—include, among many others, Baltimore Harbor, the Patapsco River, Lake Roland, and the Back River.

9. Baltimore Harbor is an economic engine for the City and the greater Baltimore region. As one recent report indicates, "the sediments beneath [the Harbor's] waters remain toxic—not only with the residue of past industrial activities, but also nutrient and sediment runoff from city streets and parks."

10. The report also noted, "PCBs … appear[] in extremely high concentrations in the Inner Harbor, which may reflect the influence of stormwater runoff carried to the harbor from Jones Falls."

11. This is consistent with a December 2012 joint EPA and U.S. Geological Survey report on PCB contamination in the Chesapeake Bay and surrounding waters, which found "severe" PCB contamination in certain "hot spots" around the Bay, including Baltimore Harbor.

12. The available data strongly suggest that Baltimore City's stormwater system and Maryland waters surrounding and adjacent to Baltimore, including Lake Roland and Baltimore Harbor, are substantially impaired by PCBs.

13. By this action, Plaintiff asserts claims for public nuisance, strict liability (design defect and failure to warn), and negligence, against Defendants to redress the widespread contamination of the City's stormwater and other water systems or bodies within the boundaries of Baltimore caused by Defendants' wrongful conduct in connection with the design, manufacture, marketing, sale, and distribution of PCBs.

14. Plaintiff brings this action solely in its governmental capacity. All claims asserted in this action are premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and are brought solely for the public benefit. This action as a whole, and each claim separately, tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor. Any such profit or emolument that may otherwise inure, as a result of this lawsuit, to Plaintiff as a proprietor is hereby disavowed.

15. Plaintiff seeks all damages, including punitive or exemplary damages, to which it is entitled as a result of Defendants' conduct, as well as declaratory and injunctive relief, as set forth below.

Plaintiff MAYOR AND CITY COUNCIL OF BALTIMORE hereby alleges, upon information and belief, in part, as follows:

II. PARTIES

16. The MAYOR AND CITY COUNCIL OF BALTIMORE ("the City," or "Plaintiff") is a municipal corporation, duly organized and existing by virtue of the laws of the State of Maryland.

17. In order to discharge stormwater from the MS4, the City is subject to a Phase I Municipal Separate Storm Sewer Permit issued by the State of Maryland, Department of the Environment, pursuant to the National Pollutant Discharge Elimination System under the Clean Water Act.

18. Discharges from the City's other systems, including its sewage system and potable water system, are also governed by National Pollutant Discharge Elimination System ("NPDES") permits.

19. The City has spent considerable funds on impervious surface restoration efforts, which provide qualitative stormwater benefits, and will begin to monitor PCB concentrations in its stormwater discharges, which will require a significant monetary commitment. Once this study has been completed, the City will develop a strategy to address PCB discharges from its stormwater system.

20. Fish and shellfish that reside in Lake Roland are contaminated with PCBs at levels that make them unfit for human consumption. Such condition has impaired and damaged Lake Roland, a recreational resource owned and operated by the City.

21. The City must retrofit its stormwater system in order to manage, remove, and reduce the presence of PCBs in its stormwater system and Lake Roland, among other waters.

22. Defendant Monsanto Company ("Monsanto") is a Delaware corporation with its principal place of business in St. Louis, Missouri.

23. Defendant Solutia, Inc. ("Solutia") is a Delaware corporation with its headquarters and principal place of business in St. Louis, Missouri.

24. Defendant Pharmacia, LLC (formerly known as "Pharmacia Corporation" and successor to the original Monsanto Company) is a Delaware LLC with its principal place of business in Peapack, New Jersey. Pharmacia is now a wholly-owned subsidiary of Pfizer, Inc.

25. The original Monsanto Company ("Old Monsanto") operated an agricultural products business, a pharmaceutical and nutrition business, and a chemical products business. Old Monsanto began manufacturing PCBs in the 1930s and continued to manufacture commercial PCBs until the late 1970s.

26. Through a series of transactions beginning in approximately 1997, Old Monsanto's businesses were spun off to form three separate corporations. The corporation now known as Monsanto operates Old Monsanto's agricultural products business. Old Monsanto's chemical products business is now operated by Solutia. Old Monsanto's pharmaceuticals business is now operated by Pharmacia.

27. Solutia was organized by Old Monsanto to own and operate its chemical manufacturing business. Solutia assumed the operations, assets, and liabilities of Old Monsanto's chemicals business.

28. Although Solutia assumed and agreed to indemnify Pharmacia (then known as Monsanto Company) for certain liabilities related to the chemicals business, Defendants have entered into agreements to share or apportion liabilities, and/or to indemnify one or more entity, for claims arising from Old Monsanto's chemical business --- including the manufacture and sale of PCBs.

29. In 2003, Solutia filed a voluntary petition for reorganization under Chapter 11 of the U.S. Bankruptcy Code. Solutia's reorganization was completed in 2008. In connection with Solutia's Plan of Reorganization, Solutia, Pharmacia and New Monsanto entered into several agreements under which Monsanto continues to manage and assume financial responsibility for certain tort litigation and environmental remediation related to the Chemicals Business.

30. Monsanto, Solutia, and Pharmacia are collectively referred to in this Complaint as "Defendants."

III. JURISDICTION AND VENUE

31. This Court has jurisdiction pursuant to 28 U.S.C. § 1332 because complete diversity exists between Plaintiff and Defendants. The Plaintiff is located in Maryland, but no Defendant is a citizen of Maryland. Monsanto is a Delaware corporation with its principal place of business in St. Louis, Missouri. Solutia is a Delaware corporation with its principal place of business in St. Louis, Missouri. Pharmacia is a Delaware limited liability company with its principal place of business in Peapack, New Jersey.

32. Venue is appropriate in this judicial district pursuant to 28 U.S.C. § 1391(a) because all of the property that is the subject of the action is situated in this judicial district.

IV. FACTUAL ALLEGATIONS

A. PCBs are Toxic Chemicals that Cause Environmental Contamination.

33. Polychlorinated biphenyl, or "PCB," is a molecule comprised of chlorine atoms attached to a double carbon-hydrogen ring (a "biphenyl" ring). A "PCB congener" is any single, unique chemical compound in the PCB category. Over two hundred congeners have been identified.

34. PCBs were generally manufactured as mixtures of congeners. From approximately 1935 to 1977, Monsanto Company was the only manufacturer in the United States that intentionally produced PCBs for commercial use. The most common trade name for PCBs in the United States was "Aroclor," which was trademarked by Old Monsanto.

35. Monsanto's commercially-produced PCBs were used in a wide range of industrial applications in the United States including electrical equipment such as transformers, motor start capacitors, and lighting ballasts. In addition, PCBs were incorporated into a variety of products such as caulks, paints, and sealants.

36. As used in this Complaint, the terms "PCB," "PCBs," "PCB-containing products," and "PCB products" refer to products containing polychlorinated biphenyl congener(s) manufactured for placement into trade or commerce, including any product that forms a component part of or that is subsequently incorporated into another product.

37. PCBs easily migrate out of their original source material or enclosure and contaminate nearby surfaces, air, water, soil, and other materials. For example, PCB compounds volatilize out of building materials (such as caulk) into surrounding materials such as masonry, wood, drywall, and soil, thereby causing damage to those surrounding materials and entering the natural environment. PCBs can also escape from totally-enclosed materials (such as light ballasts) and similarly contaminate and damage surrounding materials, leading to their introduction into the natural environment.

38. PCBs present serious risks to the health of humans, wildlife, and the environment.

39. Humans may be exposed to PCBs through ingestion, inhalation, and dermal contact. Individuals may inhale PCBs that are emitted into the air. They may also ingest PCBs that are emitted into air and settle onto surfaces that come into contact with food or drinks. And they may absorb PCBs from physical contact with PCBs or PCB-containing materials.

40. EPA has determined that Monsanto's PCBs are probable human carcinogens. In 1996, EPA reassessed PCB carcinogenicity, based on data related to Aroclors 1016, 1242, 1254, and 1260. EPA's cancer reassessment was peer reviewed by 15 experts on PCBs, including scientists from government, academia and industry, all of whom agreed that PCBs are probable human carcinogens.

41. The International Agency for Research on Cancer published an assessment in 2015 that asserts an even stronger relationship between PCBs and human cancer. The report explains: "There is sufficient evidence in humans for the carcinogenicity of polychlorinated biphenyls

(PCBs). PCBs cause malignant melanoma. Positive associations have been observed for non-Hodgkin's lymphoma and cancer of the breast. ... PCBs are carcinogenic to humans ... ."

42. In addition, EPA concluded that PCBs are associated with serious non-cancer health effects. From extensive studies of animals and primates using environmentally relevant doses, EPA has found evidence that PCBs exert significant toxic effects, including effects on the immune system, the reproductive system, the nervous system, and the endocrine system.

43. PCBs affect the immune system by causing a significant decrease in the size of the thymus gland, lowered immune response, and decreased resistance to viruses and other infections. The animal studies were not able to identify a level of PCB exposure that did not affect the immune system. Human studies confirmed immune system suppression.

44. Studies of reproductive effects in human populations exposed to PCBs show decreased birth weight and a significant decrease in gestational age with increasing exposures to PCBs. Animal studies have shown that PCB exposures reduce birth weight, conception rates, live birth rates, and reduced sperm counts.

45. Human and animal studies confirm that PCB exposure causes persistent and significant deficits in neurological development, affecting visual recognition, short-term memory, and learning. Some of these studies were conducted using the types of PCBs most commonly found in human breast milk.

46. PCBs may also disrupt the normal function of the endocrine system. PCBs have been shown to affect thyroid hormone levels in both animals and humans. In animals, decreased thyroid hormone levels have resulted in developmental deficits, including deficits in hearing. PCB exposures have also been associated with changes in thyroid hormone levels in infants in studies conducted in the Netherlands and Japan.

47. PCBs have been associated with other health effects including elevated blood pressure, serum triglyceride, and serum cholesterol in humans; dermal and ocular effects in monkeys and humans; and liver toxicity in rodents.

48. Children may be affected to a greater extent than adults. The Agency for Toxic Substances and Disease Registry explained: "Younger children may be particularly vulnerable to PCBs because, compared to adults, they are growing more rapidly and generally have lower and distinct profiles of biotransformation enzymes, as well as much smaller fat deposits for sequestering the lipophilic PCBs."

49. PCBs are known to be toxic to a number of aquatic species and wildlife including fish, marine mammals, reptiles, amphibians, and birds. Exposure is associated with death, compromised immune system function, adverse effects on reproduction, development, and endocrine function. PCB exposure affects liver function, the digestive system, and nervous systems and can promote cancer in a number of animal species. The presence of PCBs can cause changes in community and ecosystem structure and function.

B. Monsanto Has Long Known of PCBs' Toxicity.

50. Monsanto was well aware of scientific literature published in the 1930s that established that inhalation in industrial settings resulted in toxic systemic effects.

51. An October 11, 1937, Monsanto memorandum advises that "Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to **systemic toxic effects**. Repeated bodily contact with the liquid Aroclors may lead to an acne-form skin eruption."[1]

52. A September 20, 1955, memo from Emmet Kelly, Monsanto's Medical Director, set out Monsanto's position with respect to PCB toxicity: "**We know Aroclors are toxic,** but the

[1] Exhibit 1 (MONS 061332).

actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an individual develop[s] any type of liver disease and gives a history of Aroclor exposure. I am sure the juries would not pay a great deal of attention to [maximum allowable concentrates]."[2]

53. On November 14, 1955, Monsanto's Medical Department provided an opinion that workers should not be allowed to eat lunch in the Aroclor department:

> It has long been the opinion of the Medical Department that eating in process departments is a potentially hazardous procedure that could lead to serious difficulties. While the Aroclors are not particularly hazardous from our own experience, this is a difficult problem to define because early literature work claimed that chlorinated biphenyls were quite toxic materials by ingestion or inhalation.[3]

54. On January 21, 1957, Emmet Kelly reported that after conducting its own tests, the U.S. Navy decided against using Monsanto's Aroclors: "No matter how we discussed the situation, it was impossible to change their thinking that Pydraul 150 is just **too toxic** for use in a submarine."[4]

55. In 1966, Kelly reviewed a presentation by Swedish researcher Soren Jensen, who stated that PCBs "appeared to be the **most injurious** chlorinated compounds of all tested."[5] Jensen refers to a 1939 study associating PCBs with the deaths of three young workers and concluding that "pregnant women and persons who have at any time had any liver disease are particularly

[2] Exhibit 2 (MONS 095196).

[3] Exhibit 3 (no Bates number).

[4] Exhibit 4 (MONS 095640).

[5] Exhibit 5 (JDGFOX00000037).

susceptible."[6] Kelly does not dispute any of Jensen's remarks, noting only, "As far as the section on toxicology is concerned, it is true that chloracne and liver trouble can result from large doses."[7]

56. On January 29, 1970, Elmer Wheeler of the Monsanto Medical Department circulated laboratory reports discussing results of animal studies. He noted: "Our interpretation is that the PCB's are exhibiting a greater degree of toxicity in this chronic study than we had anticipated. Secondly, although there are variations depending on species of animals, **the PCB's are about the same as DDT in mammals**."[8]

C. Monsanto Has Long Known that PCBs Were "Global Contaminants" Causing Harm to Animals and Fish.

57. Monsanto became aware that PCBs were causing widespread contamination of the environment, far beyond the areas of its immediate use, during the time period in which it was producing and selling PCBs.

58. In 1966, *New Scientist* published a note titled, "Report of a New Chemical Hazard," indicating that "[a] Swedish research worker has expressed concern over the increased amounts of polychlorinated biphenyl (PCB) entering the air, presumably from industrial smoke and rubbish-dump smoke, and being absorbed by water and taken up by fish and later humans." The note also states that PCBs are "related to and as poisonous as DDT," and summarizes then-ongoing research by Dr. Jensen showing PCB concentrations detected in pike, fish and fish-spawn, eagles, and his own, and his family's, hair. The note further states that "PCB is much harder to break down than DDT and there is every reason to suppose that it is much more difficult to get it out of the system,"

[6] *Id*. at JDGFOX00000039.

[7] *Id*. at JDGFOX00000037.

[8] Exhibit 6 (MONS 098480).

observing that PCBs have been "detected in the air over London and Hamburg and also in seals caught off Scotland. It can therefore be presumed to be widespread throughout the world."[9]

59. Monsanto—which also manufactured DDT for decades—knew that PCBs shared many chemical, toxicological, and environmental properties with DDT. Monsanto knew DDT posed grave environmental risks and threatened the public health as well as the health of wildlife, aquatic life, and the natural environmental more generally.

60. By the late 1940s, scientific researchers had established that DDT and other chlorinated hydrocarbons (a class of chemicals to which PCBs also belong) are absorbed and stored in fatty tissue of living organisms exposed to them, and pass these contaminants on to their offspring in milk. For instance, the *American Journal of Public Health* published a 1950 report warning that "chlorinated hydrocarbons, such as DDT and chlordane, are soluble in fats and are stored in the fatty tissues of the body. These compounds possess a high order of toxicity, and their uncontrolled or unwise use is not desirable." Extensive scientific research establishing the toxicity and bioaccumulative and biopersistent nature of DDT and other chlorinated hydrocarbons was published from the 1940s to the 1960s.

61. Following publication of the *New Scientist* report, Monsanto's Medical Director, Emmet Kelly, in 1966, obtained and reviewed the academic conference presentation by Dr. Jensen that apparently underlies the report.[10] In the presentation, Jensen reported that the "main characteristic[s]" of PCBs are "[t]heir very high stability," their lack of "metaboliz[ation] in living organism[s]," and their non-flammability.[11] The presentation also reports the detection of PCBs

[9] Exhibit 7 (773987).

[10] Exhibit 5.

[11] *Id.* at -38.

in the tissues of fish and wildlife in Sweden and indicates that the source is likely from industrial uses of PCBs rather than agriculture.[12]

62. A December 1968 article by Professor Richard Risebrough identified chlorinated hydrocarbons (which include PCBs) as "the most abundant synthetic pollutants present in the global environment." The article reported finding significant concentrations of PCBs in the bodies and eggs of peregrine falcons and 34 other bird species. The report linked PCBs to the rapid decline in peregrine falcon populations in the United States.

63. On March 6, 1969, Monsanto employee W. R. Richard wrote a memorandum summarizing Risebrough's article cited above, as concluding that PCBs are "toxic substance[s]," "widely spread by air-water; therefore, an uncontrollable pollutant . . . causing extinction of peregrine falcon … [and] endangering man himself."[13] Richard explained that Monsanto could take steps to reduce PCB releases from its own plants but cautioned, "It will be still more difficult to control other end uses such as cutting oils, adhesives, plastics, and NCR paper. In these applications exposure to consumers is greater and the disposal problem becomes complex."[14]

64. On September 9, 1969, Richard wrote an interoffice memo titled "Defense of Aroclor."[15] He acknowledged the role of Aroclor in water pollution: "Aroclor product is refractive, will settle out on solids – sewerage sludge – river bottoms, and apparently has a long life." He noted that Aroclors 1254 and 1260 had been found along the Gulf Coast of Florida causing a problem with shrimp; in San Francisco Bay, where it was reported to thin egg shells in birds; and in the Great Lakes. Richard advised that the company could not defend against all

[12] *Id.* at -46.

[13] Exhibit 8 (MONS 096509).

[14] *Id*.

[15] Exhibit 9 (DSW 014256).

criticism but should limit Aroclor uses and immediately engage in remediation measures: "We can't defend vs. everything. Some animals or fish or insects will be harmed. Aroclor degradation rate will be slow. Tough to defend against. Higher chlorination compounds will be worse [than] lower chlorine compounds. Therefore, we will have to restrict uses and clean-up as much as we can, starting immediately."[16]

65. The Aroclor Ad Hoc Committee held its first meeting on September 5, 1969. The committee's objectives were to continue sales and profits of Aroclors in light of the fact that PCB "may be a **global contaminant**."[17] The meeting minutes acknowledge that PCB had been found in fish, oysters, shrimp, birds, along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries, Lake Michigan, Pensacola Bay, and in Western wildlife. Moreover, the committee implicated the normal use of PCB-containing products as the cause of the problem: "In one application alone (highway paints), one million lbs/year are used. **Through abrasion and leaching we can assume that nearly all of this Aroclor winds up in the environment**."[18]

66. A month later, on October 2, 1969, the Ad Hoc Committee reported extensive environmental contamination. The U.S. Department of Interior, Fish and Wildlife found PCB residues in dead eagles and marine birds. Similarly, the Bureau of Commercial Fisheries reported finding PCBs in the river below Monsanto's Pensacola plant. The U.S. Food and Drug Administration had discovered PCBs in milk supplies. The Committee advised that Monsanto could not protect the environment from Aroclors as "global" contaminants, but could protect the continued manufacture and sale of Aroclors:

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[16] *Id*.

[17] Exhibit 10 (MONS 030483).

[18] *Id*. at -85.

> There is little probability that any action that can be taken will prevent the growing incrimination of specific polychlorinated biphenyls (the higher chlorinated – e.g. Aroclors 1254 and 1260) as nearly global environmental contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp), and the possible extinction of several species of fish eating birds.
>
> Secondly, the committee believes that there is no practical course of action that can so effectively police the uses of these products as to prevent environmental contamination. There are, however a number of actions which must be undertaken to prolong the manufacture, sale and use of these particular Aroclors as well as to protect the continued use of other members of the Aroclor series.[19]

64. Despite growing evidence of PCBs' infiltration of every level of the global ecology, Monsanto remained steadfast in its production and marketing of Aroclors and other PCBs.

65. Monsanto expressed a desire to keep profiting from PCBs despite the environmental consequences in a PCB Presentation to its Corporate Development Committee. The Presentation suggests possible reactions to the contamination issue. It considered that doing nothing was "unacceptable from a legal, moral, and customer public relations and company policy viewpoint." But the option of going out of the Aroclor business was also considered unacceptable: "there is too much customer/market need and selfishly **too much Monsanto profit to go out**."[20]

66. Monsanto's desire to protect Aroclor sales rather than the environment is reflected in the Ad Hoc Committee's stated objectives:

> 1. Protect **continued sales and profits** of Aroclors;
> 2. Permit **continued development of new uses and sales**, and
> 3. **Protect the image** of the Organic Division and the Corporation as members of the business community recognizing their responsibilities to prevent and/or control contamination of the global ecosystem.[21]

[19] Exhibit 11 (DSW 014612), at -15.

[20] Exhibit 12 (MONS 058730), at -37.

[21] *Id*.

67. An interoffice memorandum circulated on February 16, 1970, provided talking points for discussions with customers in response to Monsanto's decision to eliminate Aroclors 1254 and 1260: "We (your customer and Monsanto) are not interested in using a product which may present a problem to our environment." Nevertheless, the memo acknowledges that Monsanto "**can't afford to lose one dollar of business**." To that end, it says, "We want to avoid any situation where a customer wants to return fluid. . . . We would prefer that the customer use up his current inventory and purchase [new products] when available. He will then top off with the new fluid and eventually all Aroclor 1254 and Aroclor 1260 will be out of his system. We don't want to take fluid back." [22]

68. Even worse, Monsanto instructed its customers to dispose of PCB containing material in local landfills, knowing that landfills were not suitable for PCB contaminated waste. Monsanto had determined that the only effective method of disposing of PCBs was incineration, and it constructed an incinerator for disposal of its own PCB contaminants. Nevertheless, as Monsanto's Manager of Environmental Control, William Papageorge, explained in his 1975 testimony before the Wisconsin Department of Natural Resources, Monsanto instructed its customers to dispose of PCB contaminated waste in landfills: "lacking that resource [a commercial incinerator], we have to reluctantly suggest, because we don't have a better answer, that they find a well operated, properly operated landfill and dispose of the material in that fashion."[23]

[22] Exhibit 13 (MONS 100123).

[23] *See* Testimony of William Papageorge, Public Hearing to Review and Receive Public Comment Upon Proposed Administrative Rules Relating to the Discharge of Polychlorinated Biphenyls (PCB's) Into the Waters of the State, Before the Department of Natural Resources (August 28-29, 1975).

69. In 1970, the year after Monsanto formed the Ad Hoc Committee, and despite Monsanto's actual knowledge of the global reach of PCB contamination, PCB production in the United States peaked at 85 million pounds.

70. Growing awareness of the ubiquitous nature of PCBs led the United States to conduct an investigation of health and environmental effects and contamination of food and other products. An interdepartmental task force concluded in May 1972 that PCBs were highly persistent, could bioaccumulate to relatively high levels, and could have serious adverse health effects on human health.

71. After the 1972 report, the EPA undertook a study to assess PCB levels in the environment on a national basis. Culminating in a 1976 report, the EPA study revealed widespread occurrence of PCBs in bottom sediments in several states; in fish and birds; in lakes and rivers; in the Atlantic Ocean, the Pacific Ocean, and the Gulf of Mexico; sewage treatment facilities; in a variety of foods including milk, poultry, eggs, fish, meat, and grains; and in human tissues, blood, hair, and milk. The EPA concluded, PCBs were a "more serious and continuing environmental and health threat than had been originally realized."

72. Meanwhile, up until at least 1970, Monsanto was aggressively promoting the expanded use and sale of Aroclor and other PCB compounds, including in consumer products. In a 1960 brochure, Monsanto promoted the use of Aroclors in transformers and capacitors, utility transmission lines, home appliances, electric motors, fluorescent light ballasts, wire or cable coatings, impregnants for insulation, dielectric sealants, chemical processing vessels, food cookers, potato chip fryers, drying ovens, thermostats, furnaces, and vacuum diffusion pumps. Aroclors could also be used, the brochure advertised, as a component of automotive transmission oil; insecticides; natural waxes used in dental casting, aircraft parts, and jewelry; abrasives; specialized lubricants; industrial cutting oils; adhesives; moisture-proof coatings; printing inks;

papers; mastics; sealant; caulking compounds; tack coatings; plasticizers; resin; asphalt; paints, varnishes, and lacquers; masonry coatings for swimming pools, stucco homes, and highway paints; protective and decorative coatings for steel structures, railway tank and gondola cars; wood and metal maritime equipment; and coatings for chemical plants, boats, and highway marking.[24]

73. A 1961 brochure touted that Monsanto's Aroclors were being used in "lacquers for women's shoes," as "a wax for the flame proofing of Christmas trees," as "floor wax," as an adhesive for bookbinding, leather, and shoes, and as invisible marking ink used to make chenille rugs and spreads. [25]

74. Thus, by February 1961, at the latest, Monsanto possessed actual knowledge that its Aroclors were being used in a variety of industrial, commercial, household, and consumer goods, and affirmatively promoted these uses by encouraging salesmen to market products for these and other applications.

75. A few years later, in 1970, Monsanto began to distance itself from the variety of applications of Aroclors that it had proudly espoused a few years before. In a press release, the company claimed: "What should be emphasized . . . is that PCB was developed over 40 years ago primarily for use as a coolant in electrical transformers and capacitors. It is also used in commercial heating and cooling systems. It is not a 'household' item."[26]

76. This message was repeated in a variety of public statements, including in a document published as "Monsanto Statement on PCBs" in the journal *Environment* in 1970. In that publication, Monsanto states that PCBs are not used in "household products" and are not "highly toxic," despite actual knowledge that PCBs were, in fact, used in household products and

[24] Exhibit 14 (LEXOLDMON004616).

[25] Exhibit 15 (0627503).

[26] Exhibit 16 (MCL000647).

were highly toxic. The publication also falsely implies that PCBs do not represent an environmental hazard because a "principal market" for PCBs is in closed electrical applications where PCBs are "completely sealed in metal containers," and because PCBs are used in polymers meant for applications as adhesives, elastomers, and surface coatings, rendering them incapable of escape, when, in fact, Monsanto knew that PCBs would inevitably escape their ordinary and intended uses to contaminate the natural environment.

D. Monsanto Concealed the Nature of PCBs from Governmental Entities.

77. While the scientific community and Monsanto knew that PCBs were toxic and becoming a global contaminant, Monsanto repeatedly misrepresented these facts, telling the public and governmental entities the exact opposite — that the compounds were not toxic and that the company would not expect to find PCBs in the environment in a widespread manner.

78. In a March 24, 1969 letter to the Los Angeles County Air Pollution Control District, Monsanto advised that the Aroclor compounds "are not particularly toxic by oral ingestion or skin absorption."[27] Addressing reports of PCBs found along the West Coast, Monsanto claimed ignorance as to their origin, explaining that "very little [Aroclor] would normally be expected either in the air or in the liquid discharges from a using industry."[28] A similar letter to the Regional Water Quality Control Board explained that PCBs are associated with "no special health problems" and "no problems associated with the environment."[29]

79. In May 1969, Monsanto employee Elmer Wheeler, in Monsanto's Medical Department, spoke with a representative of the National Air Pollution Control Administration,

[27] Exhibit 17 (NCR-FOX-0575881).

[28] *Id*.

[29] Exhibit 18 (NEV 031051).

who promised to relay to Congress the message that Monsanto "cannot conceive how the PCBs can be getting into the environment in a widespread fashion."[30]

80. Monsanto delivered the same message to the New Jersey Department of Conservation in July, 1969, claiming first, "Based on available data, manufacturing and use experience, we do not believe the [PCBs] to be seriously toxic."[31] The letter then reiterates Monsanto's position regarding environmental contamination: "[W]e are unable at this time to conceive of how the PCBs can become wide spread in the environment. It is certain that no applications to our knowledge have been made where the PCBs would be broadcast in the same fashion as the chlorinated hydrocarbon pesticides have been."[32]

81. Behind the scenes, as reflected in an internal memorandum dated February 10, 1967, prepared by Monsanto Medical Director Emmet Kelly, Monsanto was "very worried" about the negative publicity the company would suffer as a result of media coverage of the PCB contamination issue. The memo, which addresses the problem of "Aroclor in the air and in various fish and other living reservoirs," indicates: "We are very worried about what is liable to happen in the [United States] when the various technical and lay news media pick up the subject. This is especially critical at this time because air pollution is getting a tremendous amount of publicity in the United States."[33]

82. The memo continues: "We have been receiving quite a few communications from our customers, but the most critical one is NCR, who are very much involved with their carbonless copy paper. … The consensus in St. Louis is that while Monsanto would like to keep in the

[30] Exhibit 19 (NCR-FOX-0575888), at -89.

[31] Exhibit 20 (NCR-FOX-0575899).

[32] *Id*.

[33] Exhibit 21 (MONS 031358).

background in this problem, we don't see how we will be able to in the United States. We feel our customers, especially NCR, may ask us for some sort of data concerning the safety of these residues in humans. This obviously might be opening the door to an extensive and quite expensive toxicological/pharmacological investigation."[34]

83. Despite receiving such inquiries from customers about PCB toxicity and environmental risks, Monsanto failed to provide truthful and adequate warnings or instructions concerning those risks, even to its direct customers. Indeed, as alleged above, Monsanto doubled down on its campaign of deception, issuing numerous public statements and statements to regulators denying the toxicity of PCBs and denying the environmental hazards Monsanto knew PCBs posed as a result of ordinary and intended uses.

84. Monsanto had a complete and comprehensive record of all PCB-related scientific research and general reportage during the relevant time period. Indeed, in an August 6, 1971 internal memorandum, Elmer Wheeler admits that, "we have probably the world's best reference file on the PCB situation. This includes reprints from the literature beginning in 1936 to reports issued last week."[35]

E. Maryland and Baltimore Waters are "Impaired" Due to PCB Contamination

85. As described above, PCBs enter the City's stormwater and wastewater systems through no fault of the City of Baltimore. The City then lawfully discharges wastewater and stormwater in accordance with its NDPES permits.

86. As the State's fish consumption advisories demonstrate, fish from a host of rivers, creeks, harbors, reservoirs, lakes, and other waterbodies throughout the State, including Lake

[34] *Id.*

[35] Exhibit 22 (MONS 029656).

Roland have been shown to exhibit PCB contamination at levels higher than the impairment level specified by water quality standards.

87. For example, Maryland PCB fish consumption advisories recommend restricted consumption of Striped Bass from the Patapsco River and Jones Falls, and warn that various fish from the Back River should be avoided altogether.

88. Moreover, environmental research suggests that high concentrations of PCBs in local waters likely caused the declining size of the Baltimore Harbor heron colony.

89. Baltimore has taken measures to reduce the volume of PCBs in its stormwater, including by implementing impervious surface restoration efforts, and will incur additional costs to test, monitor and remediate Monsanto's PCBs in the future.

FIRST CAUSE OF ACTION
PUBLIC NUISANCE

90. Plaintiff realleges and reaffirms each and every allegation set forth in paragraphs 1-89 as if fully restated in this cause of action.

91. Plaintiff brings this cause of action in its governmental capacity. This claim is premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and is brought solely for the public benefit. This claim further tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor.

92. Monsanto manufactured, distributed, marketed, and promoted PCBs in a manner that created or contributed to the creation of a public nuisance that is harmful to health and obstructs the free use of the City's stormwater and other water systems and waters.

93. Monsanto intentionally manufactured, marketed, and sold PCBs with the knowledge that they caused global environmental contamination.

94. Monsanto knew that PCBs would likely end up in the City's stormwater systems, waterways, water bodies, sediments, fish and animal tissues, when used as intended, including in Baltimore.

95. Monsanto's conduct and the presence of PCBs annoys, injures, and endangers the comfort, repose, health, and safety of others.

96. Monsanto's conduct and the presence of PCBs interferes with and obstructs the public's free use and comfortable enjoyment of the City's waters for commerce, navigation, fishing, recreation, and aesthetic enjoyment.

97. The presence of PCBs also interferes with the free use of the City's stormwater system and waters for a healthy ecologically sound environment.

98. Monsanto's conduct and the presence of PCBs in the City's stormwater system and waters is injurious to human, animal, and environmental health.

99. An ordinary person would be reasonably annoyed or disturbed by the presence of toxic PCBs that endanger the health of fish, animals, and humans and degrade water quality and marine habitats.

100. The seriousness of the environmental and human health risk far outweighs any social utility of Monsanto's conduct in manufacturing PCBs and concealing the dangers posed to human health and the environment.

101. The rights, interests, and inconvenience to the City and general public far outweighs the rights, interests, and inconvenience to Monsanto, which profited heavily from the manufacture of PCBs and which can no longer produce PCBs.

102. Monsanto's conduct caused and continues to cause harm to the City.

103. The City has suffered and will continue to suffer damage from Monsanto's PCBs. The City incurs or will incur costs to remove PCBs that have invaded its drainage systems and to prevent additional PCBs from entering its systems. Many of the City's streets are contaminated with PCBs that enter the City's drainage systems. The City suffers injuries that are different from those suffered by the public at large.

104. The City has already incurred costs associated with impervious surface restoration efforts, and will incur additional costs to test, monitor and remediate Monsanto's PCBs in the future.

105. Monsanto knew or, in the exercise of reasonable care, should have known that the manufacture and sale of PCBs causes the type of contamination now found in the City's stormwater system and waters. Monsanto knew that PCBs would contaminate water supplies, degrade marine habitats and endanger birds and animals. In addition, Monsanto knew PCBs are

associated with serious illnesses and cancers in humans and that humans may be exposed to PCBs through ingestion of fish and/or dermal contact. As a result, it was foreseeable to Monsanto that humans would be exposed to PCBs through swimming in contaminated waters, playing on contaminated beaches, and by eating fish and shellfish from contaminated areas. Monsanto thus knew, or should have known, that PCB contamination would seriously and unreasonably interfere with the ordinary comfort, use, and enjoyment of any contaminated water body, including the City's waters. Monsanto had a duty to cease manufacturing, distributing, selling and promoting PCBs and failed to do so. Monsanto also had a duty to warn about the dangers of PCBs and failed to do so.

106. Monsanto's conduct in manufacturing, distributing, selling and promoting PCBs constitutes an unreasonable interference with a right common to the general public, i.e., the right to freely use the City's stormwater system and waters without obstruction and health hazard.

107. Monsanto is under a continuing duty to act to correct and remediate the injuries its conduct has introduced, and to warn the City, its customers, and the public about the human and environmental risks posed by its PCBs, and each day on which it fails to do so constitutes a new injury to the City.

108. The City suffered harm of a kind different from that suffered by members of the general public, namely the costly damage to its stormwater system and waters which it constructs and/or maintains for the public welfare.

109. As a direct and proximate result of Monsanto's creation of a public nuisance, the City has suffered, and continues to suffer, monetary damages to be proven at trial.

SECOND CAUSE OF ACTION
STRICT LIABILITY- DEFECTIVE DESIGN AND MANUFACTURE

110. Plaintiff realleges and reaffirms each and every allegation set forth in paragraphs 1-89 as if fully restated in this cause of action.

111. Plaintiff brings this cause of action in its governmental capacity. This claim is premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and is brought solely for the public benefit. This claim further tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor.

112. Monsanto's PCBs were not reasonably safe as designed at the time the PCBs left Monsanto's control.

113. PCBs' toxicity and inability to be contained rendered them unreasonably dangerous at all times.

114. Monsanto's PCBs were unsafe as designed as demonstrated by the United States Congress banning the production and sale of PCBs pursuant to the Toxic Substances Control Act in 1979.

115. Due to their toxicity and inability to be contained, Monsanto knew its PCBs were not safe at the time the product was manufactured because it knew that the product, even when used as intended, would become a global contaminant and cause toxic contamination of waterways and wildlife, such as the City's stormwater system, Lake Roland and the fish in Baltimore Harbor, due to the nature of PCBs.

116. Monsanto knew its PCBs were unsafe to an extent beyond that which would be contemplated by an ordinary person because of the overwhelming seriousness of creating global contamination.

117. Monsanto manufactured, distributed, sold, and promoted PCBs despite such knowledge in order to maximize its profits despite the known harm.

118. At all times relevant to this action, feasible alternatives to PCBs were available to the defendants, which could have eliminated the unreasonable dangers and hazards posed by PCBs.

119. Any utility allegedly provided by the use of PCBs is greatly outweighed by the risks and dangers associated with their use.

120. The PCBs were placed in the stream of commerce and sold by Monsanto in a defective and unreasonably dangerous condition in that they were toxic, persistent, bioaccumulative, and volatile (i.e., inevitably escaping their ordinary and intended applications), which resulted in contamination of waterways, wildlife, and water systems, including within the City.

121. The PCBs reached the City's waterways, wildlife, and water systems without any substantial change in condition and were in the same condition at the time of the alleged injury to the City's waterways, wildlife, and water systems.

122. It was foreseeable to Monsanto or a reasonable manufacturer that the PCBs would reach the City's waterways, wildlife, and water systems.

123. Contamination of the City's waterways, wildlife, and water systems occurred because of the defective design and manufacture of the PCBs.

124. Monsanto's PCBs caused and continue to cause injury to the City.

125. Monsanto is under a continuing duty to act to correct and remediate the injuries its conduct has introduced, and to warn the City, its customers, and the public about the human and environmental risks posed by its PCBs, and each day on which it fails to do so constitutes a new injury to the City.

126. The City has suffered and will continue to suffer damages in amounts to be proven at trial.

THIRD CAUSE OF ACTION
STRICT LIABILITY- FAILURE TO WARN

127. Plaintiff realleges and reaffirms each and every allegation set forth in paragraphs 1-89 as if fully restated in this count.

128. Plaintiff brings this cause of action in its governmental capacity. This claim is premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and is brought solely for the public benefit. This claim further tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor.

129. Monsanto's PCBs were not reasonably safe because they lacked adequate warnings at the time the PCBs left Monsanto's control.

130. At the time Monsanto manufactured, distributed, sold, and promoted its PCBs, Monsanto knew that PCBs, even when used as intended, would become a global contaminant and contaminate waterways and wildlife such as the City's stormwater, Lake Roland and Baltimore Harbor.

131. Despite Monsanto's knowledge, Monsanto failed to provide adequate warnings that its PCBs would become a global contaminant and contaminate waterways and wildlife, such as Baltimore's stormwater system, Lake Roland and Baltimore Harbor.

132. Monsanto could have warned of this certainty but intentionally concealed the certainty of contamination in order to maximize profits.

133. Monsanto learned and concealed the dangers of PCBs after it manufactured, distributed, promoted, and sold PCBs, and yet it did not issue warnings to those who had previously

purchased PCBs, and thereafter continued to manufacture, distribute, promote and sell PCBs without warnings.

134. Without adequate warnings or instructions, Monsanto's PCBs were unsafe to an extent beyond that which would be contemplated by an ordinary person.

135. Monsanto knowingly failed to issue warnings or instructions concerning the dangers of PCBs in the manner that a reasonably prudent manufacturer would act in the same or similar circumstances.

136. The PCBs were placed in the stream of commerce and sold by Monsanto in a defective and unreasonably dangerous condition in that their design failed to include a warning necessary for the safe and proper use and disposal of the PCBs.

137. The PCBs reached the City's waterways, wildlife, and water systems without any substantial change in condition and were in the same condition at the time of the alleged injury to the City's waterways, wildlife, and water systems.

138. It was foreseeable that the PCBs would reach the City's waterways, wildlife, and water systems.

139. Contamination of the City's waterways, wildlife, and water systems occurred because of the defective PCBs, in that to be non-defective and reasonably safe for use, the PCBs should have contained or been accompanied by a warning as to their toxicity, persistence, bioaccumulativity, and volatility.

140. Further, such contamination occurred because of Monsanto's failure to adequately warn or instruct its customers as to proper disposal techniques, including that disposal in ordinary landfills is inappropriate and would lead to environmental contamination.

141. Monsanto's PCBs caused and continue to cause injury to the City.

142. Monsanto is under a continuing duty to act to correct and remediate the injuries its conduct has introduced, and to warn the City, its customers, and the public about the human and environmental risks posed by its PCBs, and each day on which it fails to do so constitutes a new injury to the City.

143. The City has suffered and will continue to suffer damages in amounts to be proven at trial.

FOURTH CAUSE OF ACTION
TRESPASS

144. Plaintiff realleges and reaffirms each and every allegation set forth in paragraphs 1-89 as if fully restated in this count.

145. Plaintiff brings this cause of action in its governmental capacity. This claim is premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and is brought solely for the public benefit. This claim further tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor.

146. As alleged above, Monsanto manufactured, distributed, marketed, and promoted PCBs in a manner that ensured that its PCBs would invade the City's stormwater and other water systems and waterbodies.

147. As a result of such invasion, the City's public water systems, which the City operates and maintains for the public welfare, suffer contamination with toxic PCBs.

148. Such contamination is harmful to public health and obstructs the free use of the City's stormwater and other water systems and waters.

149. Monsanto intentionally manufactured, marketed, and sold PCBs with the knowledge that they caused global environmental contamination.

150. Monsanto knew that PCBs would likely end up in the City's stormwater systems, waterways, water bodies, sediments, fish and animal tissues, when used as intended, including in Baltimore.

151. Monsanto's conduct caused and will continue to cause injury to the City.

152. Monsanto is under a continuing duty to act to correct and remediate the injuries its conduct has introduced, and to warn the City, its customers, and the public about the human and environmental risks posed by its PCBs, and each day on which it fails to do so constitutes a new injury to the City.

153. As a direct and proximate result of Monsanto's trespass, the City has suffered, and continues to suffer, monetary damages to be proven at trial.

FIFTH CAUSE OF ACTION
NEGLIGENCE

154. Plaintiff realleges and reaffirms each and every allegation set forth in paragraphs 1-89 as if fully restated in this count.

155. Plaintiff brings this cause of action in its governmental capacity. This claim is premised on Plaintiff's legislative responsibility for the maintenance and operation of municipal stormwater and other water systems and waterbodies, and is brought solely for the public benefit. This claim further tends to benefit the public health and promote the welfare of the whole public, lacking any profit or emolument inuring to Plaintiff as proprietor.

156. Monsanto had a duty of care to protect others against unreasonable risks resulting from the use or disposal of its PCBs.

157. Monsanto breached its duty by failing to conform to the requisite standard of care when it negligently, carelessly, and recklessly designed, manufactured, formulated, handled, stored, labeled, instructed, controlled (or failed to control), tested (or failed to test), marketed, sold

and otherwise distributed toxic PCBs that contaminated the City's waterways, wildlife, and water systems..

158. Monsanto failed to exercise ordinary care because a reasonably careful company that learned of its product's toxicity would not manufacture that product or would warn of its toxic properties.

159. Monsanto failed to exercise ordinary care because a reasonably careful company that learned that its product could not be contained during normal production and use would not continue to manufacture that product or would warn of its dangers.

160. Monsanto failed to exercise ordinary care because a reasonably careful company would not continue to manufacture PCBs in mass quantities and to the extent that Monsanto manufactured them.

161. There is a proximate causal connection between Monsanto's breach of its duty of care and the resulting harm to the City's waterways, wildlife, and water systems.

162. Monsanto's negligence caused and continues to cause injury to the City.

163. Monsanto is under a continuing duty to act to correct and remediate the injuries its conduct has introduced, and to warn the City, its customers, and the public about the human and environmental risks posed by its PCBs, and each day on which it fails to do so constitutes a new injury to the City.

164. The City has suffered and will continue to suffer damages in amounts to be proven at trial.

PRAYER FOR RELIEF

Plaintiff prays for judgment against Defendants, jointly and severally, as follows:

1. Damages according to proof;

2. Punitive or exemplary damages sufficient to punish Defendants' use of fraudulent, malicious, or evil intent or actions and deter or warn others against commission of similar misconduct;

3. Award of the present and future costs to abate the ongoing public nuisance and/or to investigate, assess, analyze, monitor, and remediate the contamination;

4. Declaratory judgment and injunctive relief requiring Monsanto to pay for abatement of the ongoing nuisance;

5. Litigation costs and attorney's fees as permitted by law;

6. Pre-judgment and post-judgment interest;

7. Any other and further relief as the Court deems just, proper, and equitable.

DEMAND FOR JURY TRIAL

Plaintiff demands a jury trial.

Respectfully submitted,

BALTIMORE CITY DEPARTMENT OF LAW

Dated: February 19, 2019

/s/Andre M. Davis
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JS 44 (Rev. 08/16)

CIVIL COVER SHEET

The JS 44 civil cover sheet and the information contained herein neither replace nor supplement the filing and service of pleadings or other papers as required by law, except as provided by local rules of court. This form, approved by the Judicial Conference of the United States in September 1974, is required for the use of the Clerk of Court for the purpose of initiating the civil docket sheet. *(SEE INSTRUCTIONS ON NEXT PAGE OF THIS FORM.)*

I. (a) PLAINTIFFS

MAYOR AND CITY COUNCIL OF BALTIMORE
City Hall

(b) County of Residence of First Listed Plaintiff Baltmore City
(EXCEPT IN U.S. PLAINTIFF CASES)

(c) Attorneys *(Firm Name, Address, and Telephone Number)*

SEE ATTACHMENT

DEFENDANTS

MONSANTO COMPANY, et al.
c/o Corporation Service company

County of Residence of First Listed Defendant
(IN U.S. PLAINTIFF CASES ONLY)

NOTE: IN LAND CONDEMNATION CASES, USE THE LOCATION OF THE TRACT OF LAND INVOLVED.

Attorneys *(If Known)*

II. BASIS OF JURISDICTION *(Place an "X" in One Box Only)*

- ☐ 1 U.S. Government Plaintiff
- ☐ 3 Federal Question *(U.S. Government Not a Party)*
- ☐ 2 U.S. Government Defendant
- ☒ 4 Diversity *(Indicate Citizenship of Parties in Item III)*

III. CITIZENSHIP OF PRINCIPAL PARTIES *(Place an "X" in One Box for Plaintiff and One Box for Defendant)*

(For Diversity Cases Only)

	PTF	DEF		PTF	DEF
Citizen of This State	☒ 1	☐ 1	Incorporated *or* Principal Place of Business In This State	☐ 4	☐ 4
Citizen of Another State	☐ 2	☐ 2	Incorporated *and* Principal Place of Business In Another State	☐ 5	☒ 5
Citizen or Subject of a Foreign Country	☐ 3	☐ 3	Foreign Nation	☐ 6	☐ 6

IV. NATURE OF SUIT *(Place an "X" in One Box Only)*

Click here for: Nature of Suit Code Descriptions.

CONTRACT
- ☐ 110 Insurance
- ☐ 120 Marine
- ☐ 130 Miller Act
- ☐ 140 Negotiable Instrument
- ☐ 150 Recovery of Overpayment & Enforcement of Judgment
- ☐ 151 Medicare Act
- ☐ 152 Recovery of Defaulted Student Loans (Excludes Veterans)
- ☐ 153 Recovery of Overpayment of Veteran's Benefits
- ☐ 160 Stockholders' Suits
- ☐ 190 Other Contract
- ☐ 195 Contract Product Liability
- ☐ 196 Franchise

REAL PROPERTY
- ☐ 210 Land Condemnation
- ☐ 220 Foreclosure
- ☐ 230 Rent Lease & Ejectment
- ☒ 240 Torts to Land
- ☐ 245 Tort Product Liability
- ☐ 290 All Other Real Property

TORTS

PERSONAL INJURY
- ☐ 310 Airplane
- ☐ 315 Airplane Product Liability
- ☐ 320 Assault, Libel & Slander
- ☐ 330 Federal Employers' Liability
- ☐ 340 Marine
- ☐ 345 Marine Product Liability
- ☐ 350 Motor Vehicle
- ☐ 355 Motor Vehicle Product Liability
- ☐ 360 Other Personal Injury
- ☐ 362 Personal Injury - Medical Malpractice

PERSONAL INJURY
- ☐ 365 Personal Injury - Product Liability
- ☐ 367 Health Care/ Pharmaceutical Personal Injury Product Liability
- ☐ 368 Asbestos Personal Injury Product Liability

PERSONAL PROPERTY
- ☐ 370 Other Fraud
- ☐ 371 Truth in Lending
- ☐ 380 Other Personal Property Damage
- ☐ 385 Property Damage Product Liability

CIVIL RIGHTS
- ☐ 440 Other Civil Rights
- ☐ 441 Voting
- ☐ 442 Employment
- ☐ 443 Housing/ Accommodations
- ☐ 445 Amer. w/Disabilities - Employment
- ☐ 446 Amer. w/Disabilities - Other
- ☐ 448 Education

PRISONER PETITIONS

Habeas Corpus:
- ☐ 463 Alien Detainee
- ☐ 510 Motions to Vacate Sentence
- ☐ 530 General
- ☐ 535 Death Penalty

Other:
- ☐ 540 Mandamus & Other
- ☐ 550 Civil Rights
- ☐ 555 Prison Condition
- ☐ 560 Civil Detainee - Conditions of Confinement

FORFEITURE/PENALTY
- ☐ 625 Drug Related Seizure of Property 21 USC 881
- ☐ 690 Other

LABOR
- ☐ 710 Fair Labor Standards Act
- ☐ 720 Labor/Management Relations
- ☐ 740 Railway Labor Act
- ☐ 751 Family and Medical Leave Act
- ☐ 790 Other Labor Litigation
- ☐ 791 Employee Retirement Income Security Act

IMMIGRATION
- ☐ 462 Naturalization Application
- ☐ 465 Other Immigration Actions

BANKRUPTCY
- ☐ 422 Appeal 28 USC 158
- ☐ 423 Withdrawal 28 USC 157

PROPERTY RIGHTS
- ☐ 820 Copyrights
- ☐ 830 Patent
- ☐ 840 Trademark

SOCIAL SECURITY
- ☐ 861 HIA (1395ff)
- ☐ 862 Black Lung (923)
- ☐ 863 DIWC/DIWW (405(g))
- ☐ 864 SSID Title XVI
- ☐ 865 RSI (405(g))

FEDERAL TAX SUITS
- ☐ 870 Taxes (U.S. Plaintiff or Defendant)
- ☐ 871 IRS—Third Party 26 USC 7609

OTHER STATUTES
- ☐ 375 False Claims Act
- ☐ 376 Qui Tam (31 USC 3729(a))
- ☐ 400 State Reapportionment
- ☐ 410 Antitrust
- ☐ 430 Banks and Banking
- ☐ 450 Commerce
- ☐ 460 Deportation
- ☐ 470 Racketeer Influenced and Corrupt Organizations
- ☐ 480 Consumer Credit
- ☐ 490 Cable/Sat TV
- ☐ 850 Securities/Commodities/ Exchange
- ☐ 890 Other Statutory Actions
- ☐ 891 Agricultural Acts
- ☐ 893 Environmental Matters
- ☐ 895 Freedom of Information Act
- ☐ 896 Arbitration
- ☐ 899 Administrative Procedure Act/Review or Appeal of Agency Decision
- ☐ 950 Constitutionality of State Statutes

V. ORIGIN *(Place an "X" in One Box Only)*

☒ 1 Original Proceeding ☐ 2 Removed from State Court ☐ 3 Remanded from Appellate Court ☐ 4 Reinstated or Reopened ☐ 5 Transferred from Another District *(specify)* ☐ 6 Multidistrict Litigation - Transfer ☐ 8 Multidistrict Litigation - Direct File

VI. CAUSE OF ACTION

Cite the U.S. Civil Statute under which you are filing *(Do not cite jurisdictional statutes unless diversity)*:

Brief description of cause:
ENVIRONMENTAL CONTAMINATION

VII. REQUESTED IN COMPLAINT:

☐ CHECK IF THIS IS A **CLASS ACTION** UNDER RULE 23, F.R.Cv.P.

DEMAND $ 999,000.00

CHECK YES only if demanded in complaint:
JURY DEMAND: ☒ Yes ☐ No

VIII. RELATED CASE(S) IF ANY

(See instructions): JUDGE _____ DOCKET NUMBER _____

DATE
February 19, 2019

SIGNATURE OF ATTORNEY OF RECORD

FOR OFFICE USE ONLY

RECEIPT # _____ AMOUNT _____ APPLYING IFP _____ JUDGE _____ MAG. JUDGE _____

Mayor and City Council of Baltimore v. Monsanto Company, et al.

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Attorneys for Plaintiff

Exhibit 1

October 11, 1937.

"Experimental work in animals shows that prolonged exposure to Aroclor vapors evolved at high temperatures or by repeated oral ingestion will lead to systemic toxic effects.

Repeated bodily contact with the liquid Aroclors may lead to an acne-form skin eruption.

Suitable draft ventilation to control the vapors evolved at elevated temperatures, as well as protection by suitable garments from extensive bodily contact with the liquid Aroclors, should prevent any untoward effect."

In talking with Dr. Kelly before these three paragraphs were written, we agreed that they might as well be phrased so that they could be used not only in the Aroclor booklet, but quoted in correspondence as that may be necessary.

L.A. Watt

MONS 061332

Attachment 3-2

3.2

Exhibit 2

COPY

Dr. D.V.N. Hardy
Dr. H.R. Newman.

Monsanto Chemical Company

St. Louis, Missouri

September 20, 1955

Dr. J.W. Barrett

London

Your memo September 8 to Mr. Nason

AROCLOR TOXICITY

Howard Nason has given me your memo of September 8. I will be happy to discuss this with Dr. Newman during his visit here. I think, however, there are several points that I can answer you now.

You comment upon the difference in toxicity between Aroclor 1254 and 1242. This is not particularly surprising because in the earlier work it was found that toxicity increased with chlorination. Of course, from the standpoint of volatility in the case of inhalation or absorption from the gut from the point of view of ingestion are important. Frankly, there was not too great a difference between the two compounds, however. As you know, the maximum allowable concentrate is 0.1 ml/cubic meter in the case of 1254, and as high as 10.0 mgm in the case of 1268. I think the former is too low and the latter is too high. In this country they don't use the MACs very routinely, but certainly in England I think it would be alright to consider 0.2 mgm/cubic meter as perfectly safe.

I don't know how you would get any particular advantage in doing more work. What is it that you want to prove? I believe your work should be directed towards finding out what the concentrations are of Aroclor during different operations whether it is industrial or painting. The reports you have seen from Kettering Laboratory are the result of approximately $15,000 to $20,000 expenditure by MCC.

MCC's position can be summarized in this fashion. We know Aroclors are toxic but the actual limit has not been precisely defined. It does not make too much difference, it seems to me, because our main worry is what will happen if an individual developes any type of liver disease and gives a history of Aroclor exposure. I am sure the juries would not pay a great deal of attention to MACs.

COPY

We, therefore, review every new Aroclor use from this point of view. If it is an industrial application where we can get air concentrations and have some reasonable expectation that the air concentrations will stay the same, we are much more liberal in the use of Aroclor. If, however, it is distributed to householders where it can be used in almost any shape and form and we are never able to know how much of the concentration they are exposed to, we are much more strict. No amount of toxicity testing will obviate this last dilemma and therefore I do not believe any more testing would be justified.

Let's see what our discussions with Dr. Newman and yourself bring out.

R. Emmet Kelly, M.D.

REK:k

Exhibit 3

From MONSANTO CHEMICAL COMPANY

cc Mr. J. Cresce -Krumm. Plt
Mr. E. W. Lieben -" "
Mr. R. M. Webber -" "

At St. Louis

CONFIDENTIAL Date November 14, 1955

To Mr. H. B. Patrick Reference

At Krummrich Plant Subject DEPARTMENT 246 (AROCLORS)

It is the opinion of the Medical Department that the eating of lunches should not be allowed in this department for a number of reasons.

(1) Aroclor vapors and other process vapors could contaminate the lunches unless they were properly protected.

(2) When working with this material, the chance of contaminating hands and subsequently contaminating the food is a definite possiblity.

(3) It has long been the opinion of the Medical Department that eating in process departments is a potentially hazardous procedure that could lead to serious difficulties. While the Aroclors are not particularly hazardous from our own experience, this is a difficult problem to define because early literature work claimed that chlorinated biphenyls were quite toxic materials by ingestion or inhalation. In any case where a workman claimed physical harm from any contaminated food, it would be extremely difficult on the basis of past literature reports to counter such claims.

Jack T. Garrett

Jack T. Garrett

JTG:SMB

[illegible] IN 10

PLAINTIFF'S EXHIBIT 6
4403
PENGAD-Bayonne,NJ

Exhibit 4

St. Louis, Missouri

January 21, 1957

Messrs.:
G. R. Buchanan - Robts.
R. E. Hatton - M.C.
F. H. Langenfeld-Robts.
H. E. Litzsinger-Robts.
G. R. Side-Washington,D.

Mr. H. I. Armstrong

Roberts Building

FYDRAUL 150

Dr. Treon and I spent an afternoon with the Navy people to discuss Fydraul 150. Those present were Captain Shone, Captain Alvis, Captain Sessions, Commander Siegal and Mr. Mickey Albert. They discussed their information concerning Fydraul 150 which was obtained at the Naval Institute of Medical Research. While reports were not available, they had the following general data:

Skin applications of Fydraul 150 caused death in all of the rabbits tested. (The amount administered was not given.) A like amount of Cellulube 220 did not cause any deaths.

The inhalation of 10 milligrams of Fydraul 150 per cubic meter or approximately 2 tenths of a part of the Aroclor component per million for 24 hours a day for 30 days caused, statistically, definite liver damage. No matter how we discussed the situation, it was impossible to change their thinking that Fydraul 150 is just too toxic for use in a submarine. It may be that such concentrations would never be reached in the submarine but the Navy does not appear willing to even put the material in a trial run to see if it will work.

It would appear, therefore, that we should discontinue to sell Fydraul 150 for this particular application and try to develop a hydraulic fluid without Aroclor as one of its components. In this connection, Cellulube 220 is not used in a submarine but it was used in this test merely as a yardstick.

The Navy said they did not have any competitive fluid far enough along engineering-wise to even consider the toxicity of it.

R. Emmet Kelly, M.D.

REK:BMB

MONS 095640

Exhibit 5

bcc: R. E. Keller - QUEENY

February 27, 1967

Dr. M. J. Thomas
Research Division
Building No. 33
National Cash Register
Dayton 9, Ohio

Dear Dr. Thomas:

Attached is a photostat of the original paper of Dr. Jensen in Sweden, relating to polychlorinated biphenyls. I will be happy to have your ideas after you read it.

As far as the section on toxicology is concerned, it is true that chloracne and liver trouble can result from large doses. Whether or not this is at all relevant to small quantities existing in human fat is, of course, an entirely different question.

At any rate, I believe before we worry about the toxicological part of the problem, we should settle the analytical part.

Sincerely,

R. Emmet Kelly, M. D.
Medical Director

REK/ln
att.

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Mr Chairman, Ladies and gentlemen.
In honor to our Brittish guest I will try to hold this lecture in English.

As the title of this lecture states, I am today going to tell about the discovery of some hitherto unobserved chlorinated hydrocarbons having up to eight chlorine in the molecule and found in residue analysis. The chemical name of polychlorinated bifenyls (In the following called PCB). To get familiar with PCB I will start with the chemistry and toxicologi.

Chemistry

Th

The main characteristic of PCB is 1. Their very high stability. As an example they can be boiled with nitrin acid without being destroyed. 2. They are hardly metabolised in living organism. 3. if more than 4 chlorine are present they are non inflamable. It is clear that these three characteristics does it easy to understand that when they have entered the living organism the will have a low persistence . But it is difficult to explain how they find their way into the living organism. One thing seems to be clear, they don't come from agricultural use, but from a technical one and most probable it comes to the nature via wastes that are tried to be burnt up, because then we have them at once in the air, because of their non inflamability.

Toxicologi

The PCB were introduced in 1929 and as early as 1936 Jones and Aldon reported that 23 out of 24 men employed in manufacturing of PCB suffered from an acne form eruption of the skin. Acne did not appear until 6 to 8 months after the material was first used. In 1937 Drinker reported that rats exposed to chlorinated biphenyls in concentration of approximately 1 mg/m^3 for 16 hours a day for 6 weeks showed damage of the livor. After that time the allowed concentration of PCB in air is 0,5 mg/m^3. (For DDt the same value is 0.5 - 1 mg/m^3). The same authors finished their experiments in 1938, and related that these compounds have an injourious effect, manifested solely in the liver. Chlorinated bipohnyls appeared to be the most injourious chlorinated compounds of all tested.

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Greenburg, Mayer and Smith 1939 reported that PCB and polychlorinated naphtalenes are blamed for the death of three young workers, and that pregnant women and persons who have at any time had any liver diseases are particularly suspectible.

Wedel, Haller and Benton gave 1942 animals PCB including administration by inhalation, ingestion and skin absorbtion. Histological examination of the viscera showed important toxic effect only in the skin and liver, and the degeneration effects in the liver are essentially the same whatever was the method for the administration. Faribok (1955/ found as an occupational poison in the electrical industry, mixed tetra and penta chlorobiphenyl causes folliculitis, comedo, pyodermia and other skin affections, and that its principal toxic effect is fatty degeneration of the liver.

Miller (1944) injected 69 mg PCB (4 and 5 chlorine) subcontaneously in 32 guinea pigs. Eight to ten days after injection, fat droplets were noted in the liver cells, and after 16 days they were present in moderate or very large numbers. Rabbits and rats were also tested in this investigation, as well as the PCB was administated both continously, subcuntinously or ingested in the food. In the feeding experiment 8 guinea pigs received 2 doses of 69 mg of the chlorinated biphenyl 1 week apart. Death occurred in 11 to 29 days.

Finally Mc Laughlin 1964 reported a method to test the chemical toxicity and teratogenic effect by injection into the yolk sac of fertile eggs prior to incubation. PCB was found between the eight compounds among 100 tested having the highest order of toxicity. No hatch was found at a level of 25 mg pr egg. At a level of 10 mg per egg, one chick hatched out of 20 injected eggs, but died 2 days later. Some embryos which were examined after they died, showed weak deformities (often a short upper brak) and growth retardation. Lead acetate resulted as an example in no hatch at a level of 1 mg per egg. Autopsy of the dead embyos have showed extensive brain damage. Mercuric chloride showed no hatch even at a level of 0,5 mg per egg.

As the analytical chemistry is a pronounced service science I have been in contact with many scientists from other fields during the work with residue analysis, and I have always found this contact very stimulating for my own work. This co-operation often demands that we are talking the same scientific language. Because of this need I will today try to give a lecture in low level analytical chemistry for biologists, illustrated by the residue analysis of polychlorinated biphenyls.

The lecture will be divided in the following three sub-divisions:

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1. Chemistry of PCB and their toxicology.
2. Analytical methods for residue analysis and proof of structures.
3. Behaviour of PCB in nature, differencies in metabolising rate of the PCB components, potensation in an ecological serie, concentration levels and examples of samples which have been proved to contain PCB.

A residue analysis can be divided in:

1. Extraction of the pesticides from the biological material, followed by a careful cleaning-up to take away interferring substances, most often fats.
2. Identification analysis by mean of gas chromatography. Thin-layer chromatography and mass spectrometry.
3. Quantitative analysis.

At an ecological laboratory in Riksmuséet in Stockholm 1-2 g of a sample is cut out of the biological material and transferred into a weighed and carefully cleaned test tube, and stored at -20° until analysis. Smaller samples have been used, min. 5 mg of body fat, and with dry materials such as hair, feathers, pine needles 100 mg are sufficient to reach the desired 10 ng/g level in residue analysis. In cases of water proofs 1 l. is used for reaching the 10 pg/g. level.

B.1(homog) In order to facilitate complete extraction of the fatty materials from the biological sample, the doulbe amount of finely powdered anhydrous magnesium sulphate is added to the sampling tube, and the whole is homogenised with an insertable homogenizer. The resulting powder is transferred into a special Soxhlet extractor. After 4 hours of extraction the solvent is evaporated, leaving the fat in a small weighed test tube at the bottom
Sox.-tube) of the extractor. This fat is dissolved in methylene chloride in such a way that 100 ul (0,1 ml) contain 20 mg of fat.

The 100 ul solution is now transferred to a little object glass, 3 x 7 cm, covered with a silicagel layer 1 mm thick, in order to form a line 0,7 cm from one end of the slide. Inserting this thin-layer plate into a vessel the bottom of which is covered by a few mm of methylene chloride, the solvent will be sucked up in the dry layer of silicagel, and at least reach the upper end of the plate. The fact is that the fat has a greater affinity to the powder on the plate than the chlorinated hydrocarbons have. — and we get a separation. The fat being more polar than the chlorinated hydrocarbons will never go longer than 2 cm before the

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solvent reaches the upper part of the glass.

elution tube

The front of the fat appears quite visible against a lamp, and with the aid of a razor blade the zone above the fat is transferred to the elution tube and the chlorinated biocides absorbed on the powder can now be eluted by one ml of ether. The concentration is sufficient for detection of the chlorinated hydrocarbons down to the 10^{-12} g level.

5 ge

The next step in the analytical procedure concerns the separation of the different chlorinated hydrocarbons that the sample may contain. As a matter of fact, this is a troublesome task. It is easy to estimate what is not present, but more difficult to say exactly one is present. We suffer from the negative demonstration, as will be shown later.

At first a few words about the separation of the components present in the sample and their visualization.

6 ge

The separation is accomplished by mean of a gas chromatograph fitted to a detector that transfers its impulse to a recorder.

The system is shortly described:

A spirally formed glass tube with an inner diameter of 2 mm and about 2 m in length is filled up by a support, covered with an thin layer of an oil. The tube is heated in the chromatograph to about 200°. Through the tube a stream of nitrogen continously follows. When about 10 ul (1/100 of 1 ml) of the purified sample is injected into the tube, the components of the sample will be evaporized and go forward through the column with the gas stream. As the constituents have different affinity to the column filling they will pass the column with different speed and it will take different time for them to reach the detector at the other end of the glass tube. If the temperature and the nitrogen flow are held constant this time, the retention time, has a specific value for a certain compound. This is true, but unfortunately it is also a fact that two components can have the same retention time. This is one of the bigger problems in gas chromatographic analysis of unknown samples, as will soon be obvious.

To make it possible to estimate the retention time it is necessary to visualise the chlorinated hydrocarbons. For that purpose more or less specific detectors are used. The detector most often used in posticide analysis is the so called electron capture detector, which can detect down to one picogram (= 10^{-12} g of lindan). Unfortunately this detector is not specific for chlorine, bu gives answer also for oxygencontaining compounds. The response here is much lower but can be counterbalanced if the consentration of the oxygen containing is much higher. 0281423

The principle for the electron capture detector is shortly:

At the end of the gas chromatographic tube is placed a little tube containing a foil made of titanium tritide. This is an radiant. The p-

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particles are reacting with the nitrogen molecules coming from the column. Then we get + N_2 -- e^- + N_2^+. Over the detector we have a tension of 90 volt and by mean of the electrons we will get a constant electrical current over the detector. This standing current is transferred to a one-mV recorder as a constant baseline. When now a chlorinated hydrocarbon leaves the column this compound has a high affinity to the electrons and this means that the amount of electrons will diminish, and they will diminish proportionally to the amount of chlorine. The electrical current will also diminish and this is noted as a peak on the recorder. The area of the peak will be proportional to the amount of substance in the sample. By mean of a standard injection it is now possible to compare the retention time and the area of an unknown component with the retention time and area of the known standard. As said before this detector is not specific for chlrine but anyhow very useful, because of its high sensitivity. The system described has, as we have seen, two disadvantages:

1. Two different compounds can have the same retention time and be detected as one peak.
2. A registrated peak does not need to be chlorinated , because the detector is not specific.

If the sample is injected in two different columns with different chemical properties we have increased the chance for a good separation. If two compounds have the same retention time on one column they may not have it on another. When a result seems doubtful, - if the compound being responsible for a certain peak contains chlorine or not - it is possible to concentrate the sample and analyse it on a less sensitive detector such as the microcloumetric one, which is specific for chlorine. The compound is burned in a furnace and teh generated chlorine titrated directly.

As is seen from the two last mentioned possibilities it is anyhow possible to get a rather high degree of certainty in residue analysis, but it is a rather time-consumeing work.When using this method just described, we very often found that many chromatograms from residue analysis of most carefully purified samples still contain a large number of peaks. Many of these have retention times that do not agree with any known chlorinated pesticides, or their metabolites. This chromatogram con serve as an example. It was obtained by residue analysis of a sea-eagle found dead in the archipelago of Stockholm. In the range of the known peaks, there are so many unidentified that there also must be an obvious risk of the known peaks to be covered by unknown ones.

If this remark is found true, the reported results of many previous quan-

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titative analysis must be brought into question. In the present investigation it is shown that most of the unknown peak of chromatograms at residue analysis of chlorinated pesticides are due to polychlorinated biphenyls.

I will show a chromatogram of human fat analysed on a so called SF 96 column, the most often used type in pesticide analyses. Early retention times were in agreement with DDE, DDTop and DDTpp. Next slide shows the same sample analysed on a QF-1 column. Now the former 2 DDT peaks have divided into 4 peaks, and two of them are still in agreement with DDTpp and op., the two new were unknown.

Logically, these unknown components were at first thought to be metabolites of the insecticides. Against that spoke that neigther treatment nor concentrated sulfuric acid in other. This treatment made it rather sure that the compounds did not contain oxygen. In Sweden residues of organic mercury have been investigated rather intensively in the Swedish fauna. As these compounds give very high responses to the electron capture detector it was also investigated if the unknown peaks could have a mercuric origin.

It was found that the water-ecological series had high residues of both mercury (Westermark, Johnels) and the unknown ones, when the same individuals were analysed. Anyhow, the pheasant suffering most from mercury poisoning only contained low levels of electron capturing compounds and these belonged to the normal insectisides. Therefore the unknown could hardly be mercurials or metabolites of them.

As the eagle sample giving the chromatogram shown in fig. 10. could be estimated to contain DDT and DDE up to 13 g/kg in extractable fat, the amount of unknown compounds also were suggested to be in the same range, and tehn sufficiently high to do a run on the combined gas chromatograph – mass spectrometer. If this could be done successfully it would be possible to get very important informations about the chemical nature of the unknown, for ex. the molekular weight numbers of chlorine etc. This method is up to now the method giving the highest degree of certainty in the low level analytical chemistry, amounts of 100 ng substance being enough.

As this method for identification of totally unknown residues surely will be very important in the future (when f.ex. a biologist has found that fishes in a river die) it may be possible by mean of this method to find out exactly what compounds are responsible for the death. For this reason, I will go into some details with this method. In the actual case we took the extract from 20 mg eagle and concentrated

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it as much as possible and made an injection on the gas chromatograph combined with the mass spectrometer. The result was the chromatogram shown on the next slide. Every time the recorder showed that a compound is leaving the column, the effluent is led to the mass spectrometer. Now just a few words about the mass spec.

The molecules leaving the column are bomded with electrons at E. We have now got the molecule positive charged, but with the same mass as before. This M^+ is accelerated in a vacuum and will then get a kinetic energi. where is the speed. Next comes the magnetic field that tries to bend the direction of the molecule. This will be big for a small molecule and less for

If we have a sieve in the other end we can directly read the molecular weight. Added to this parent molecule M^+ we will also get addition informations, because of the fact that M^+ may not be stbble, a part of them will be broken down before they reach the sieve in the other end.

F.ex. M^+_{DDT} $M^+_{DDT} - CCl_3$

Mass spectrograms from the different unknown peaks in the eagle sample as shown. The mass numbers equal to the molecular weights or the unknowns could be read to 426,392, 358, 324. Astonishingly, the molecular differences were constantly 34 mass units. This difference shows a familarity in origin of the unknown. Now the fact is that chlorine exsists as a mixture of two isotopes with atom weights 35 and 37 in proportion 75:25. If the molecule has one chlorine, this will give two molecule peaks, one for Cl_{35} and one for Cl_{37}. If there are two chlorine we have the possibility of one with only Cl_{35}, one with both Cl_{35} and 37 and one with 2 Cl_{37} and therefore

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The relation of the peaks found on the different mass spec were:

Molecular weight	324	358	392	426
Chlorine content	5	6	7	8

An explanation of the familiarity of the compounds can be given if one substance is built from the former by substituting a hydrogen with chlorine

$$RH \quad M^+ + Cl_2 \qquad RCl \quad M^+ + 34 + HCl$$

Then it is possibl to calculate the molecular weight of the parent hydrocarbon PHC.

$M_{PHC} = M - x\,M_{Cl} + x\,M_H$, where M is the molecular weight of the component having x chlorine atoms. F.ex. for m = 426 and 8 Cl we will get M_{PHC} = 426 - 280 + 8 = 154 and equal with the other molekyls.

The most probable formula with carbon and hydrogen giving this molecular weight is $C_{12}H_{10}$ and this can only be satisfied when the parent-hydrocarbon is biphenyl, and the unknown being polychlorinated biphenyls. This explanation was later fully verified by injection of a synthetic PBC on the mass spec.

Furthermore extensive gas chromatographic investigations proved that the PBC standard gave peaks with the same retention time as the unknown peaks from the sea eagle.

With the method just described I suppose that we have a new possibility to study the residues in the air because the pine needles can allways be . We have had great difficult: in quantifying the PCB, but when getting a little more time it will be possible. We have done a few calculations on a few species, and I suppose they are right within a factor 2. We have found the residue to be from

It has been my statement here to-day to present this method for studies of defiling of the nature, and with this method a new type of defiling agents has been found to be present in nature, and a few experiment have shown where they may be found.

Now this method is going to be used in the first hadn to estimate how the situation is in nature as a whole, and in the other hand to find the leaks throug which they find its way to nature. Some maybe are present here today to get news about the leaks, and to them I want to say come back in a year.

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So much I think I can say again that the PCB hardly can come from agriculture. As support for this suggestion I can say that we have found PCB in eagle feathers from Riksmuseet from 1944, where hardly any chlorinated pesticides were used in agricultrue. One more thing that I find important to say is that in contrast to the mercury problem this does not seem to be a pure Swedish problem. I have just studied chromatograms taken from London air, and they clearly contain PCB, and dr. Holden has told me that he also find them in his fishsamples. But finally in waiting at more results Ishould like to point out one morething. It is proved that PCB comes to nature, we dont know now where they are used, but they are very persistant to chemicals and to fire. I think the poison jury should try to state that a content of PCB shall always be found in an open declaration.

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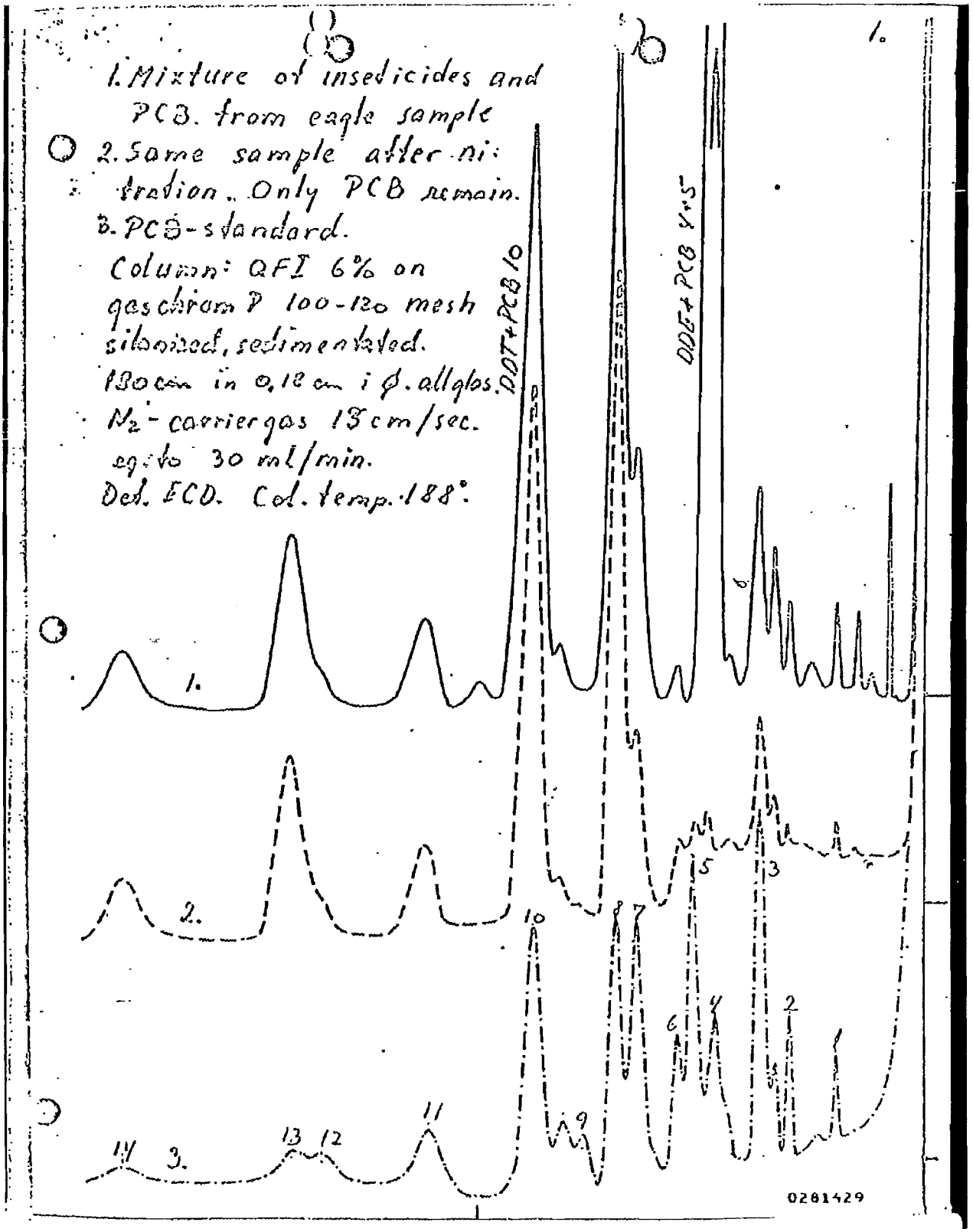

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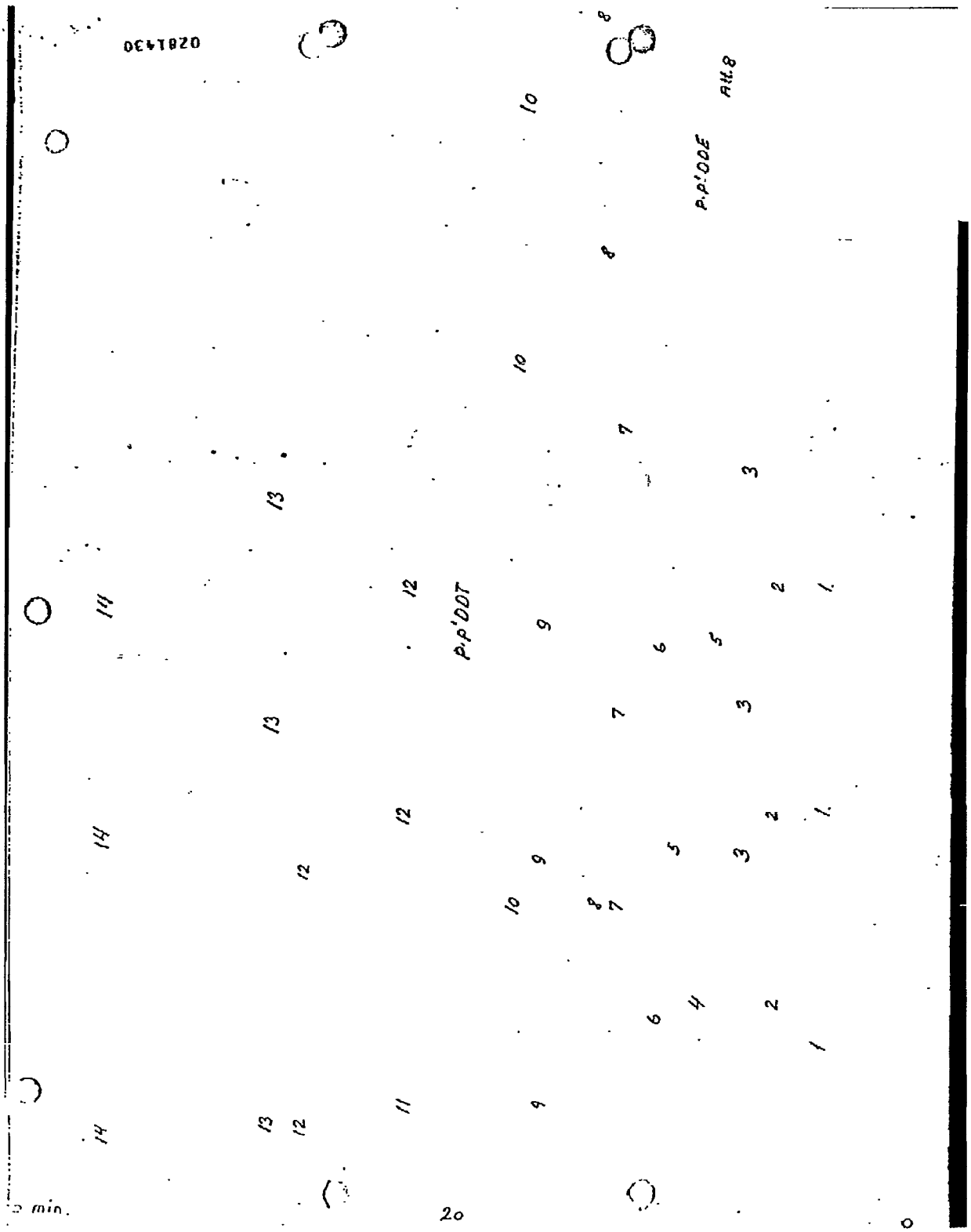
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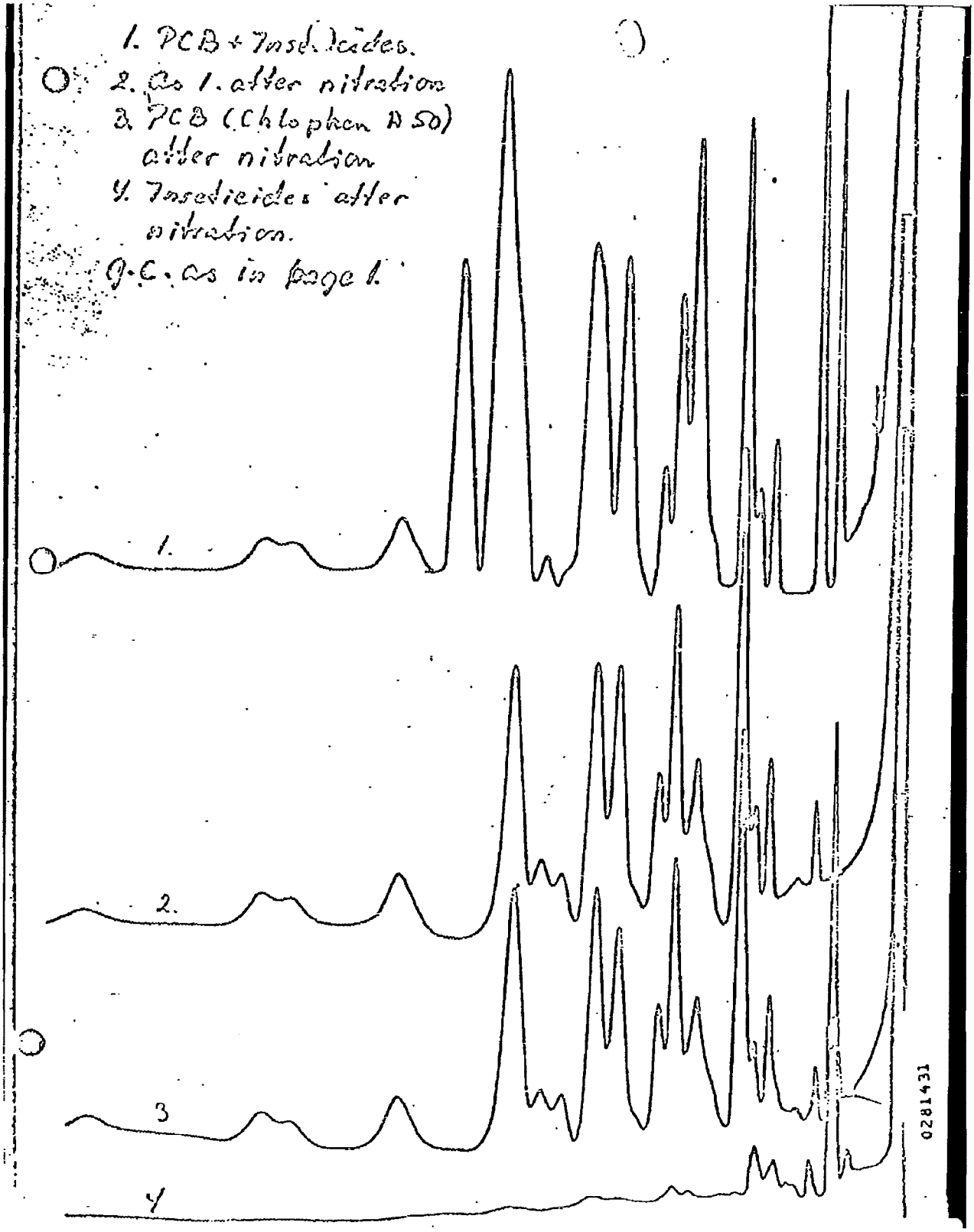
Alt.8
P,P'DDT
min.
20



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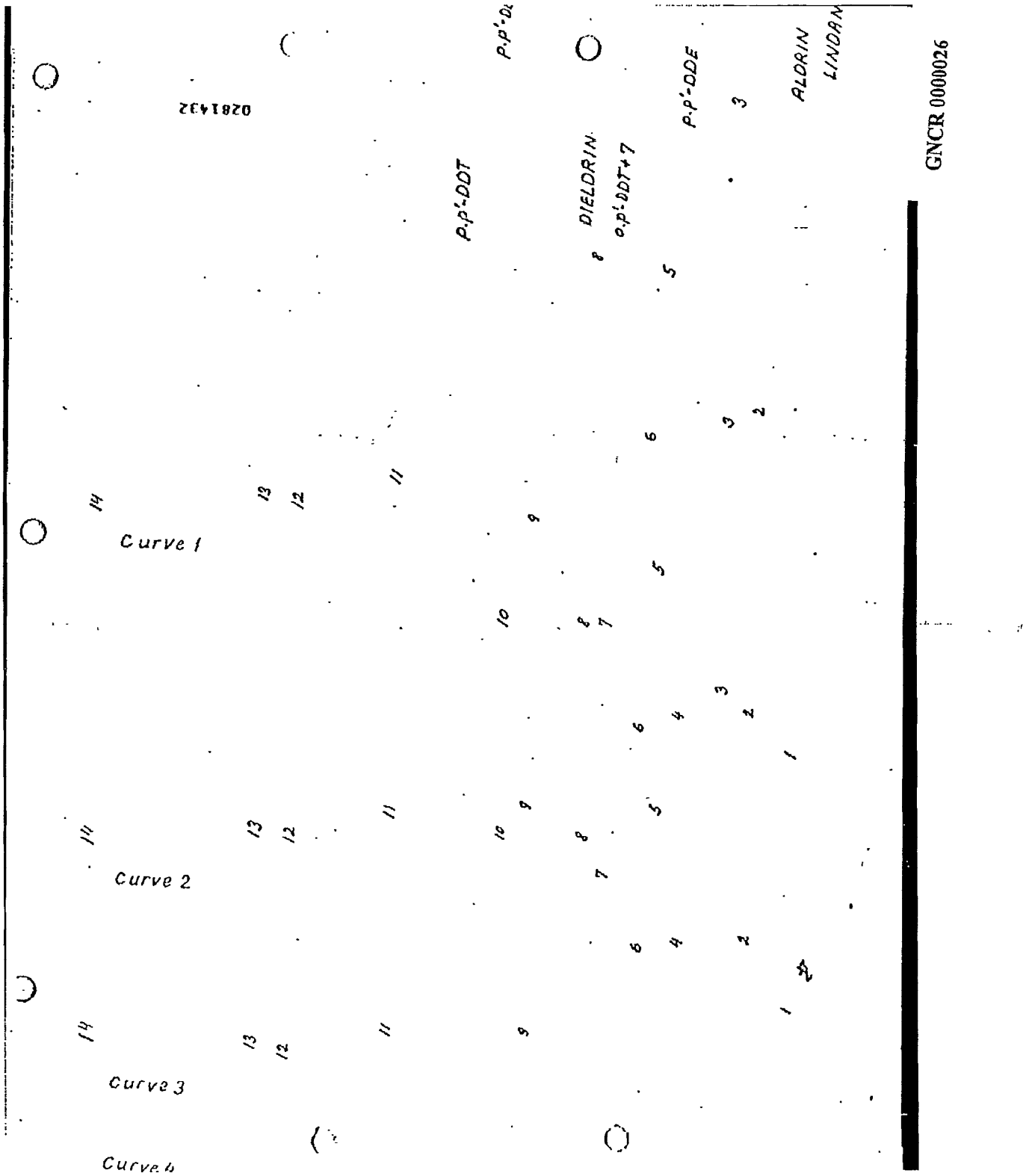
0281432
P,P'-DDT
DIELDRIN
o,p'-DDT+7
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ALDRIN
LINDAN
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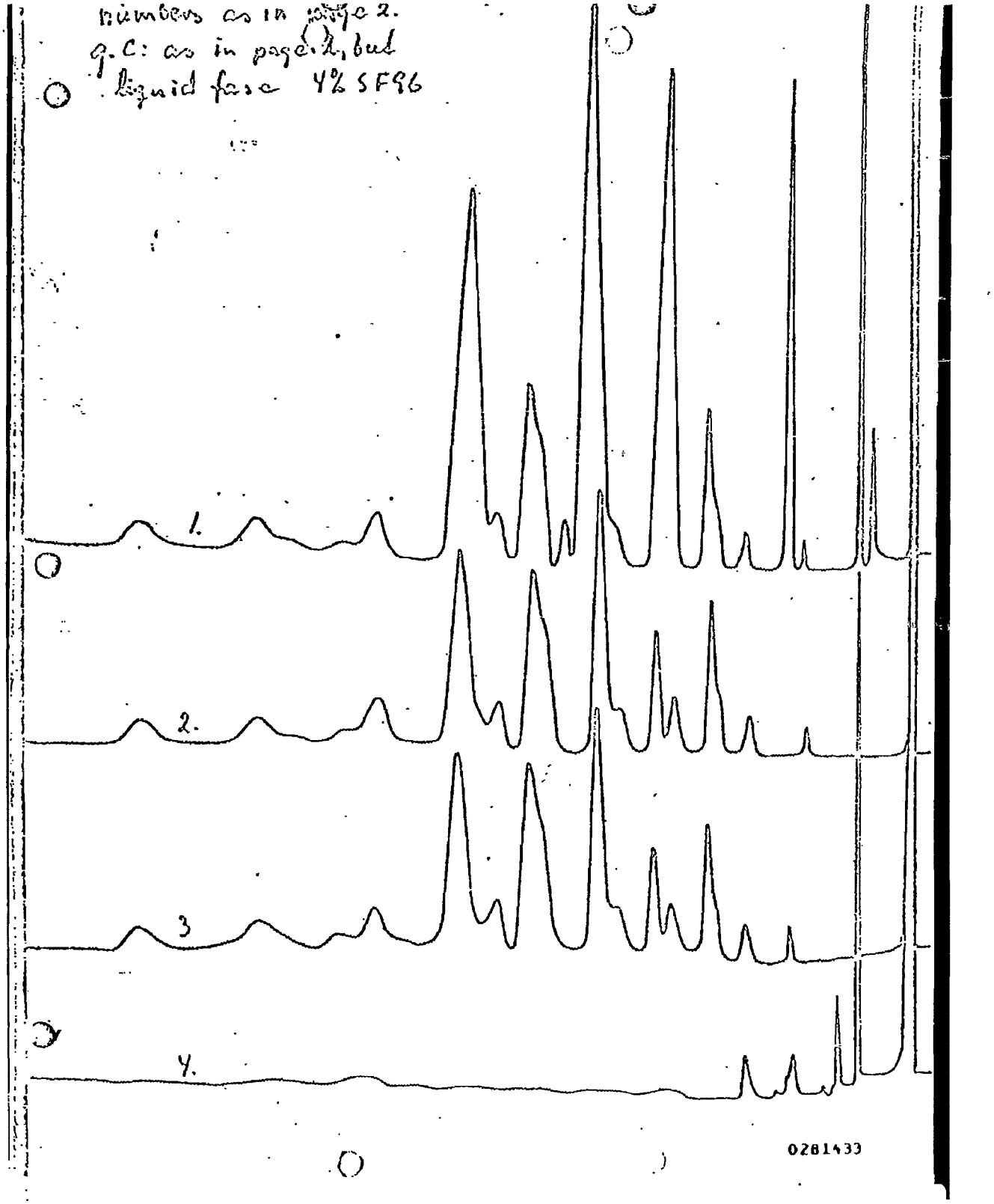
Curve 1
Curve 2
Curve 3
Curve 4



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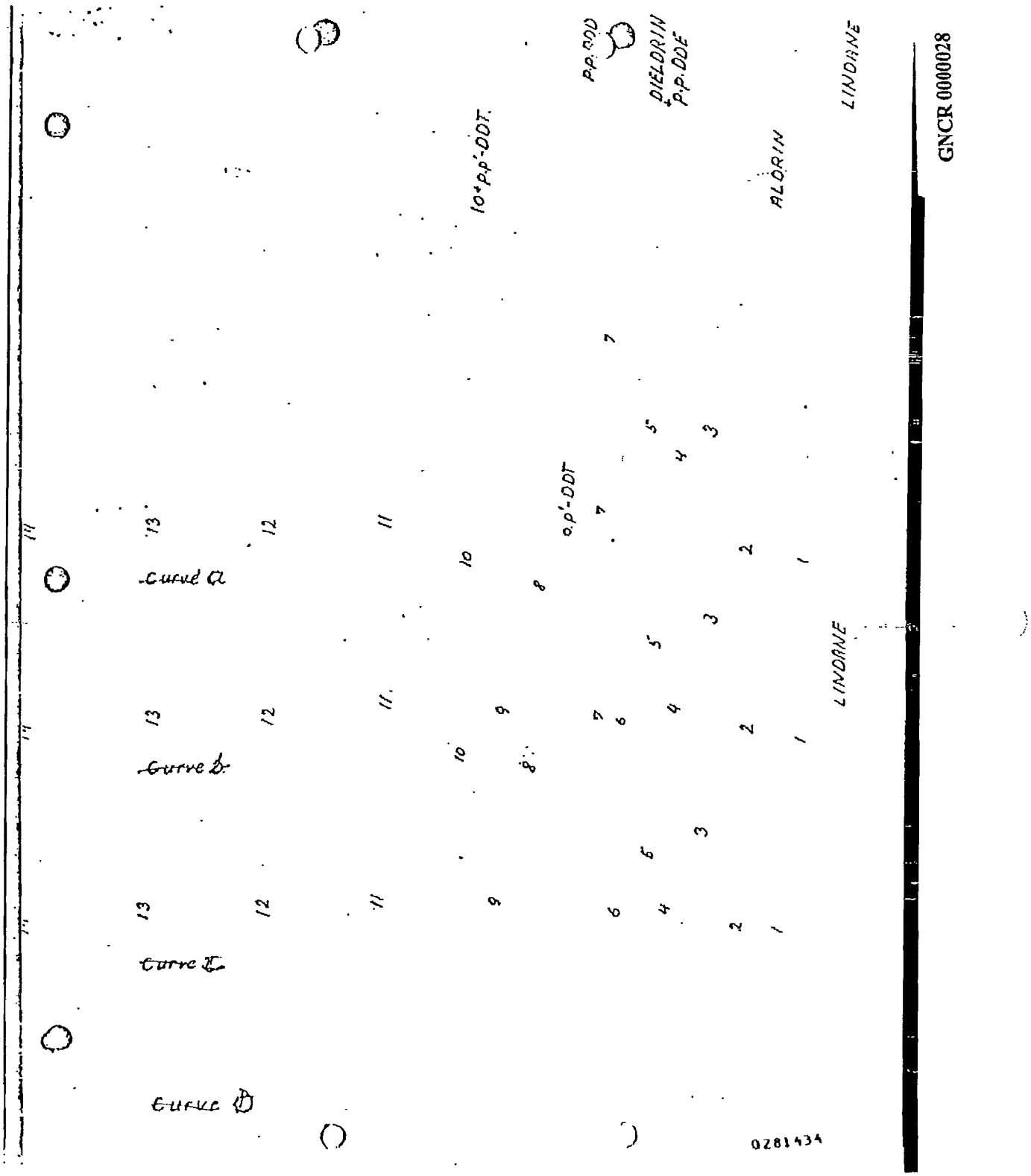
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Curve B
Curve C
Curve D
0281434

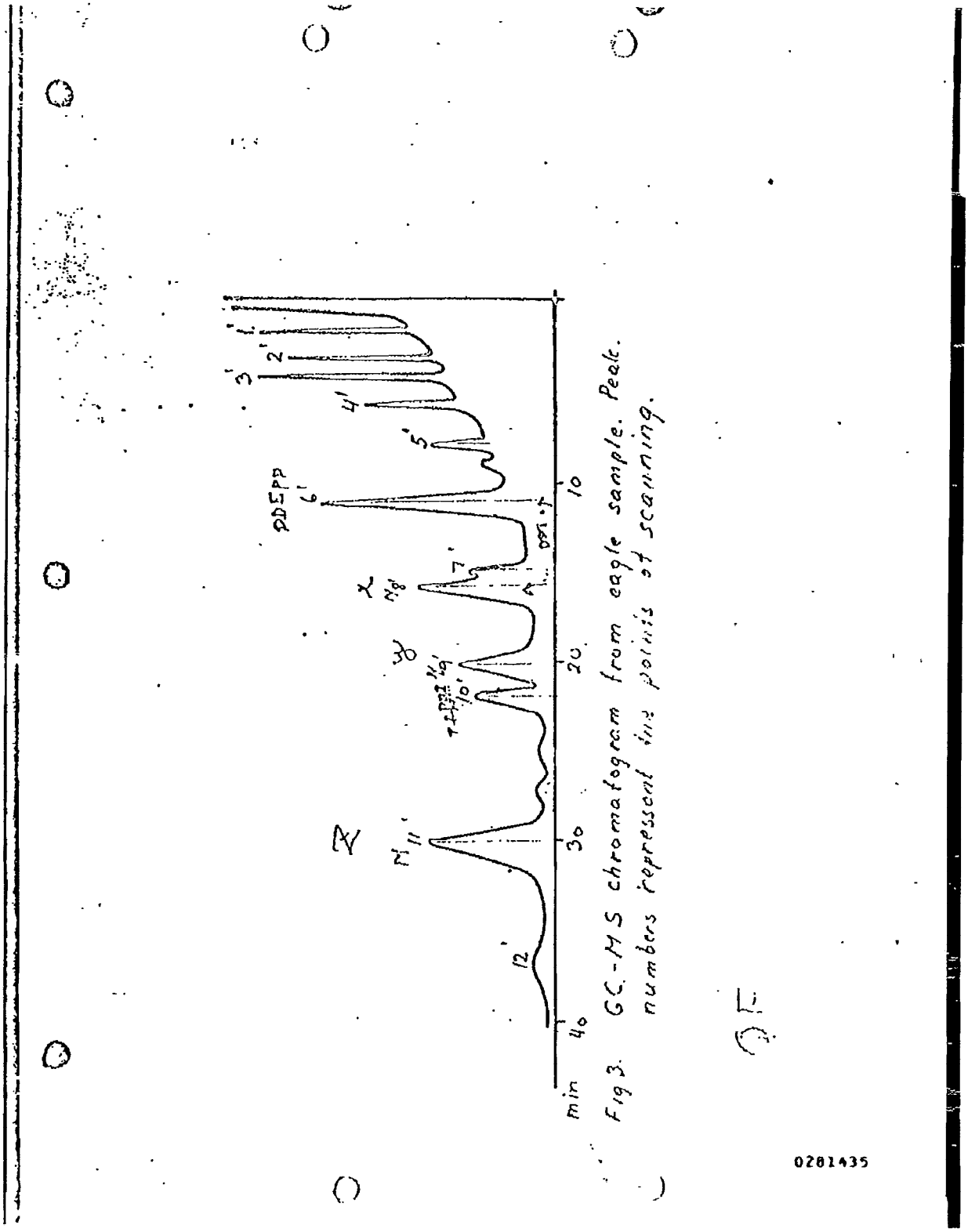

Fig 3. GC-MS chromatogram from eagle sample. Peak numbers represent time points of scanning.

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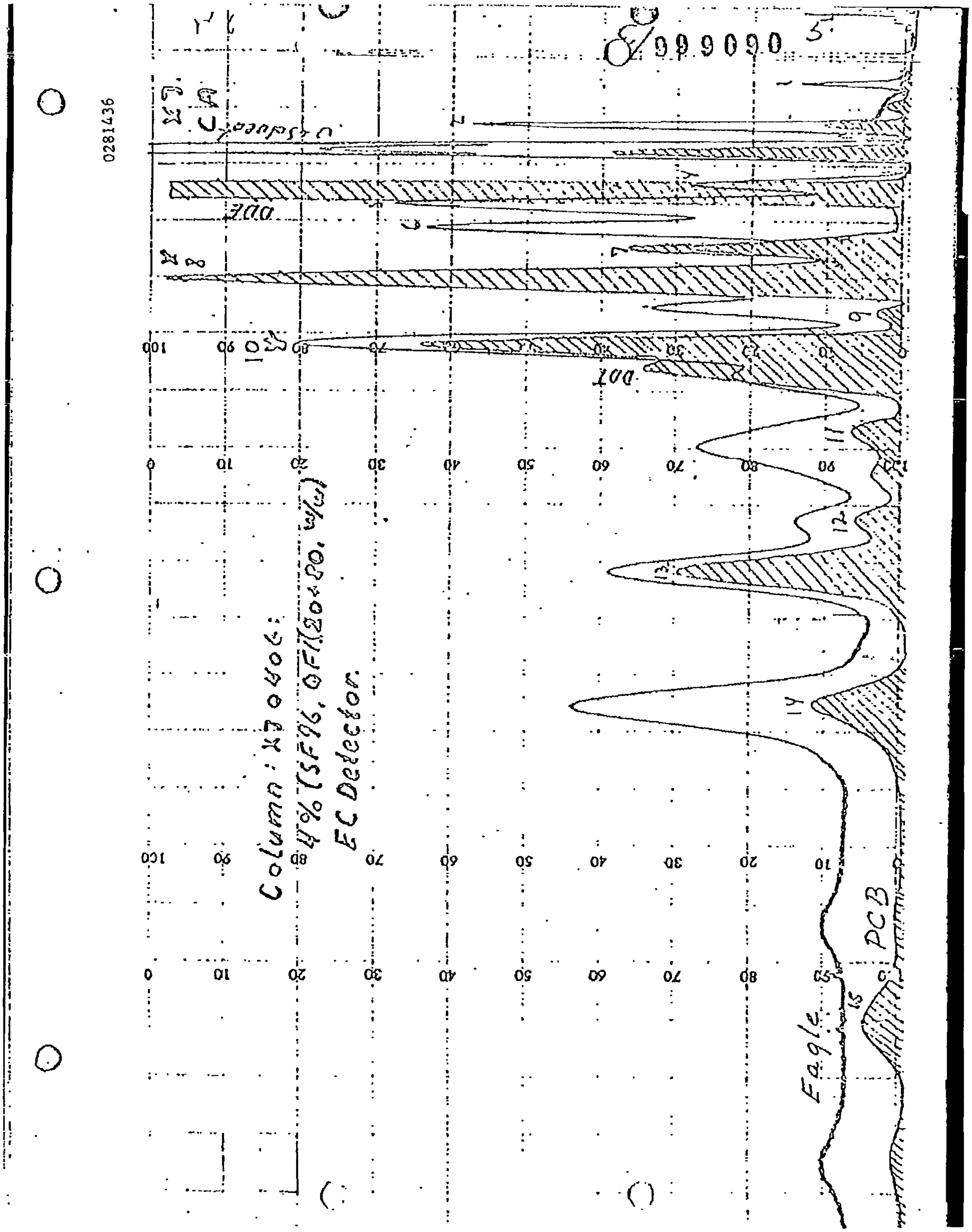

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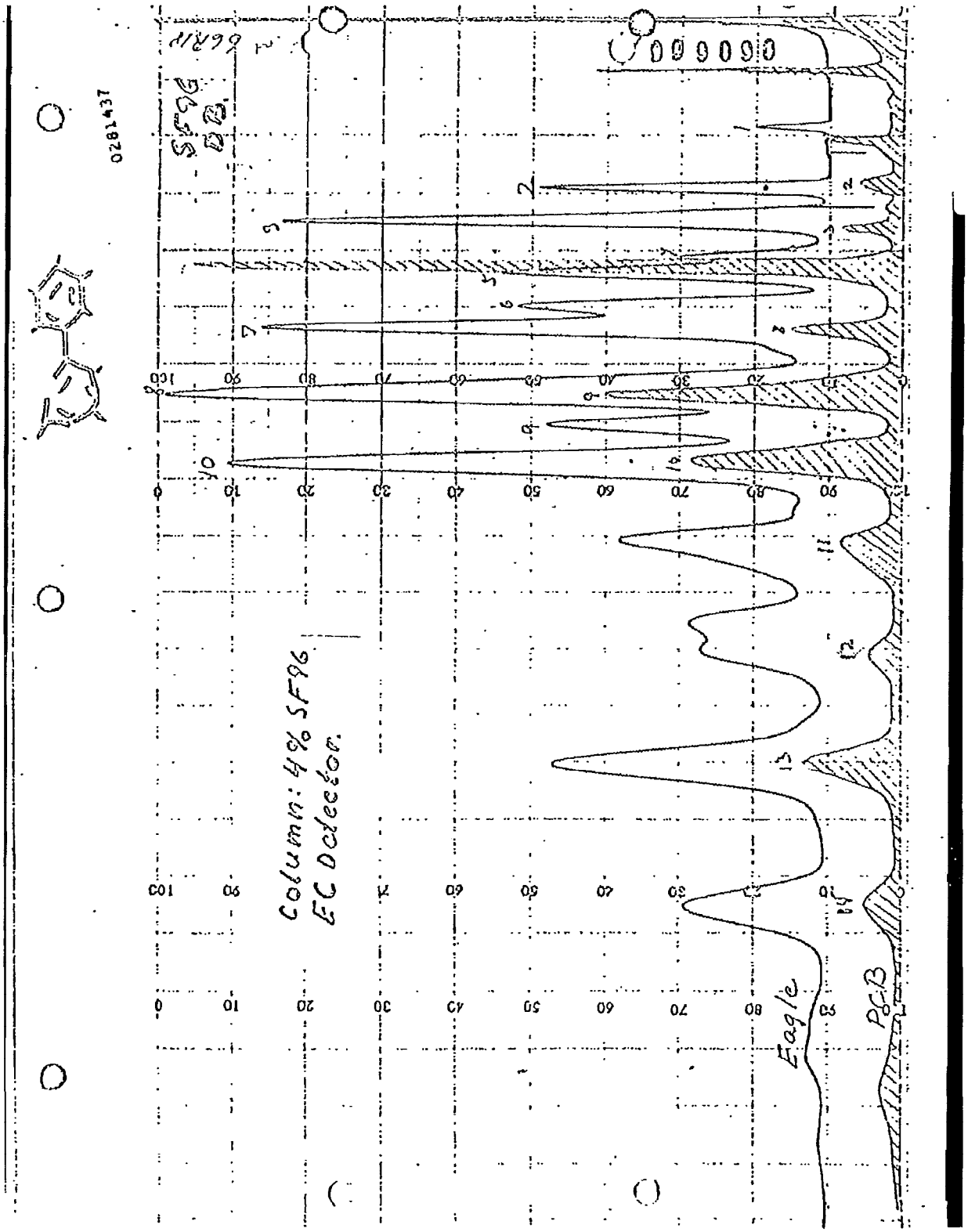
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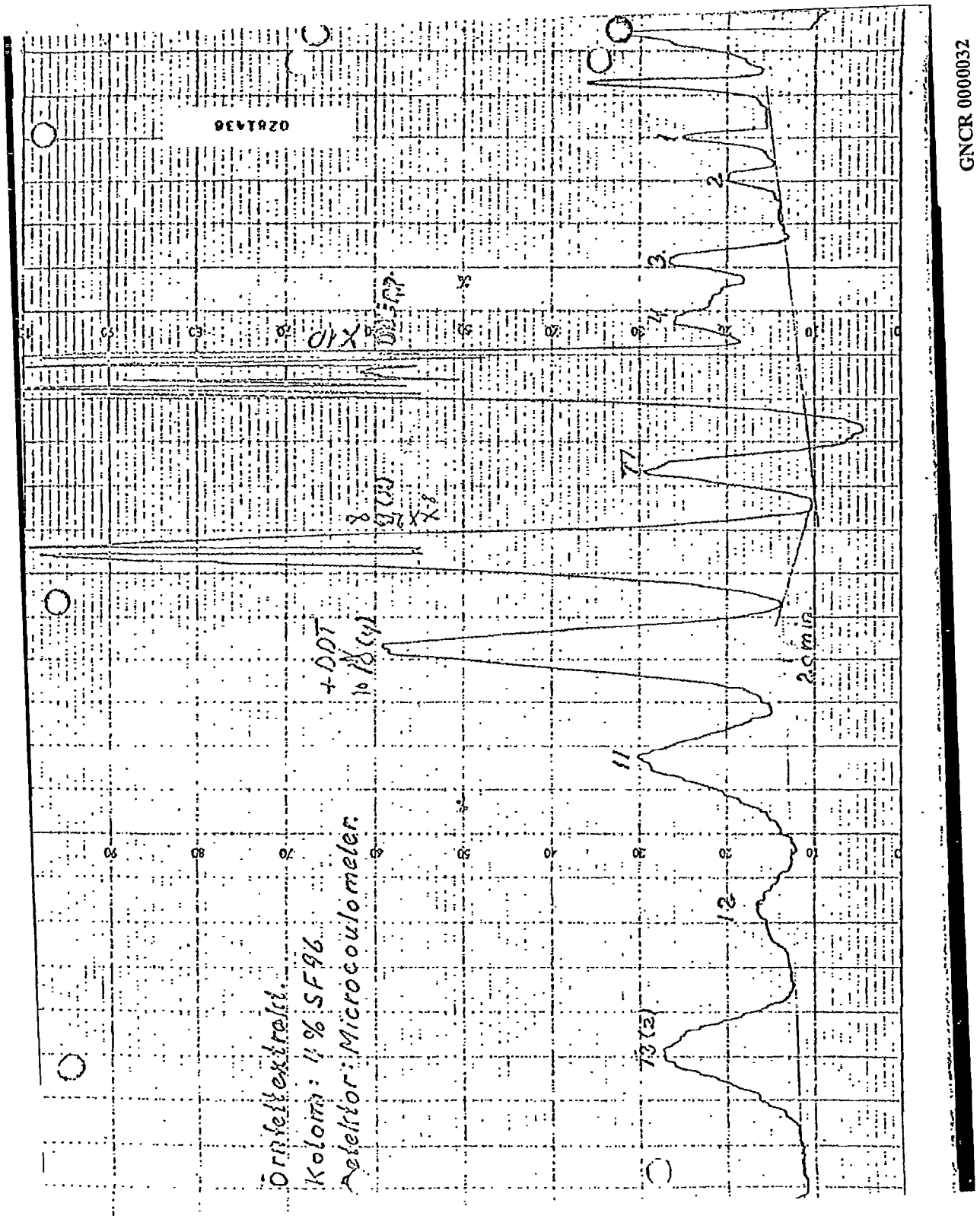
EC Detector
Eagle
PCB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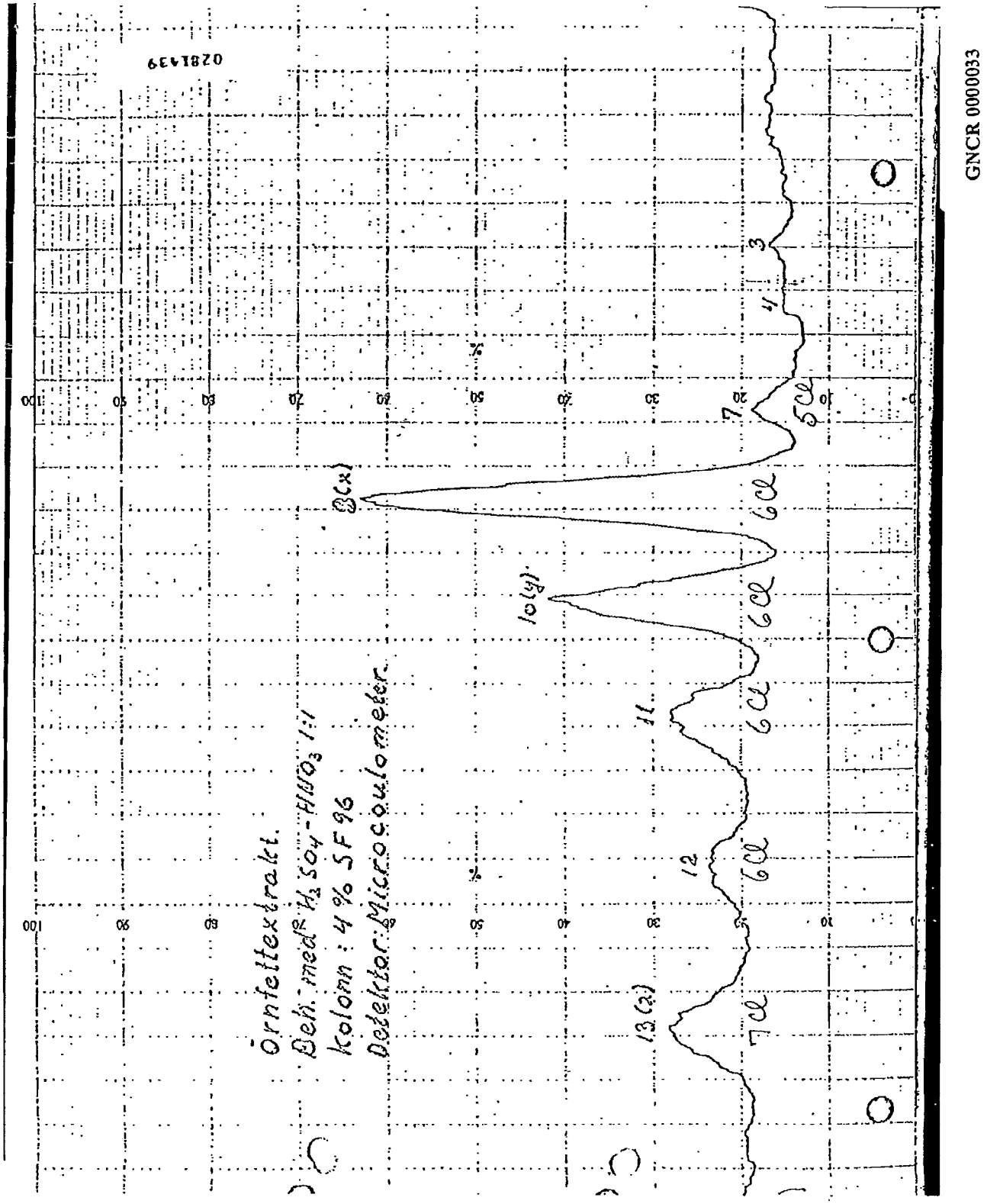
Ornatellexilis.
Kolonn: 1% SF96
Detektor: Microcoulometer.
+DDT
2,0 min



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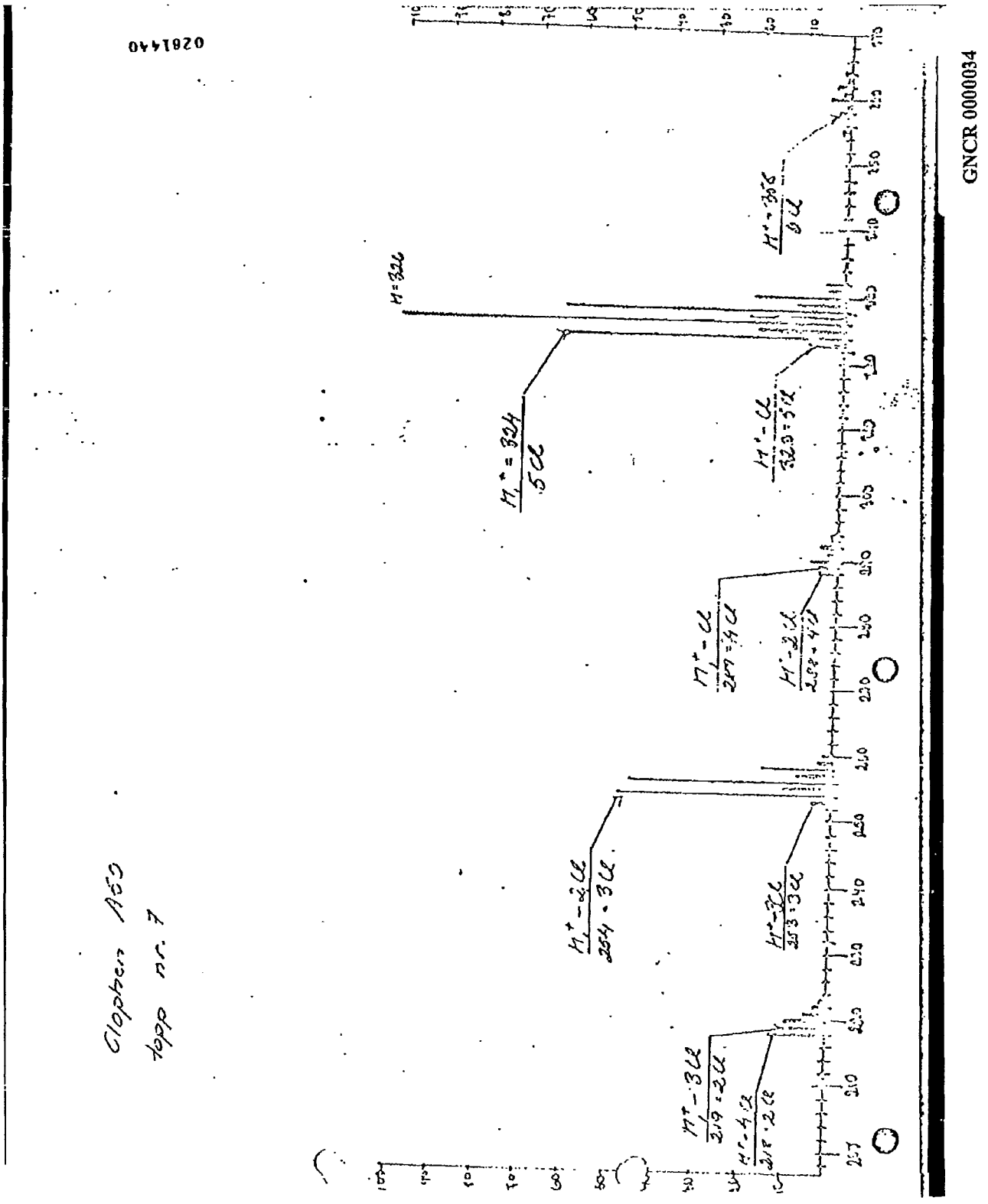
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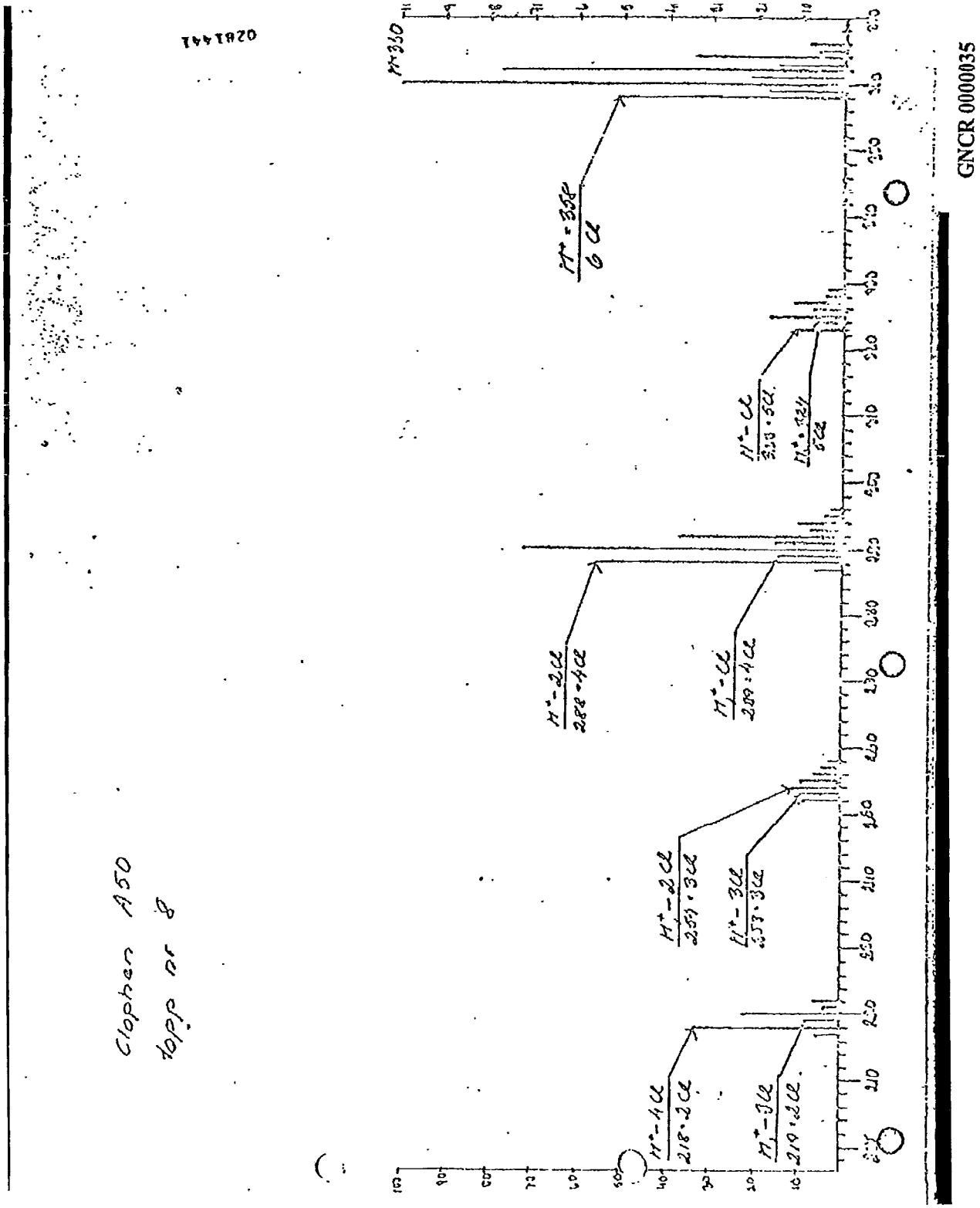
GNCR 0000034


GNCR 0000035
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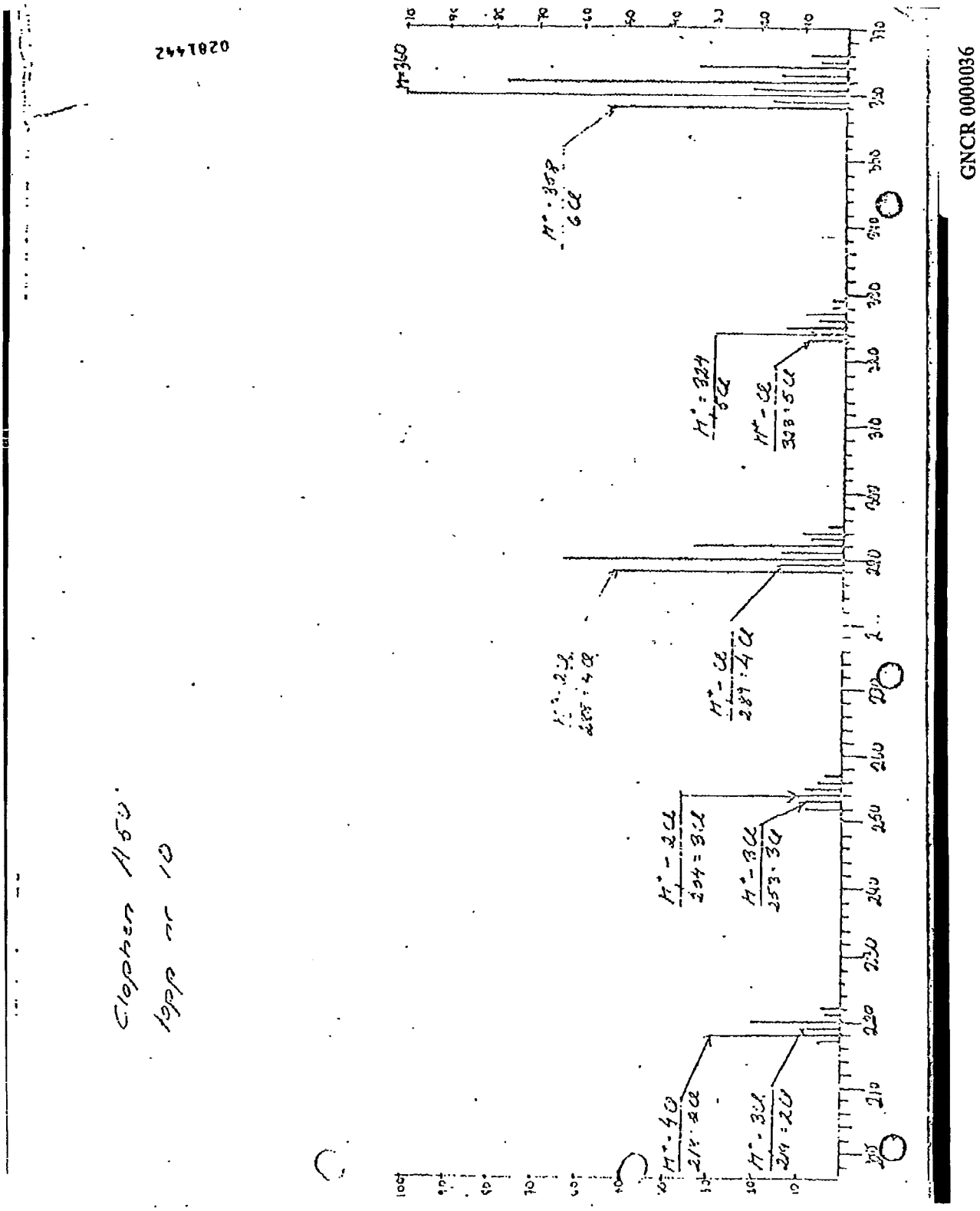
dope or 8



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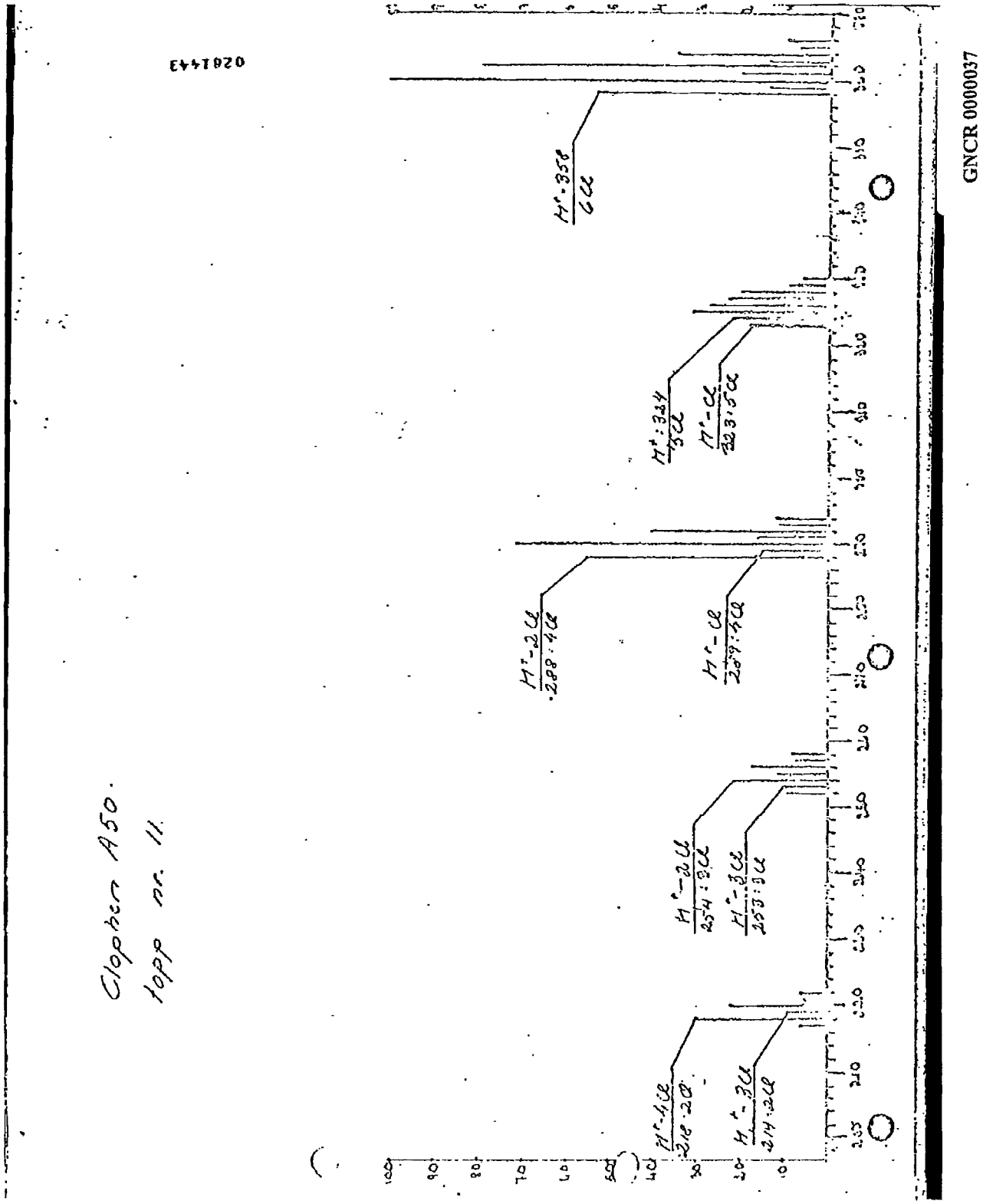
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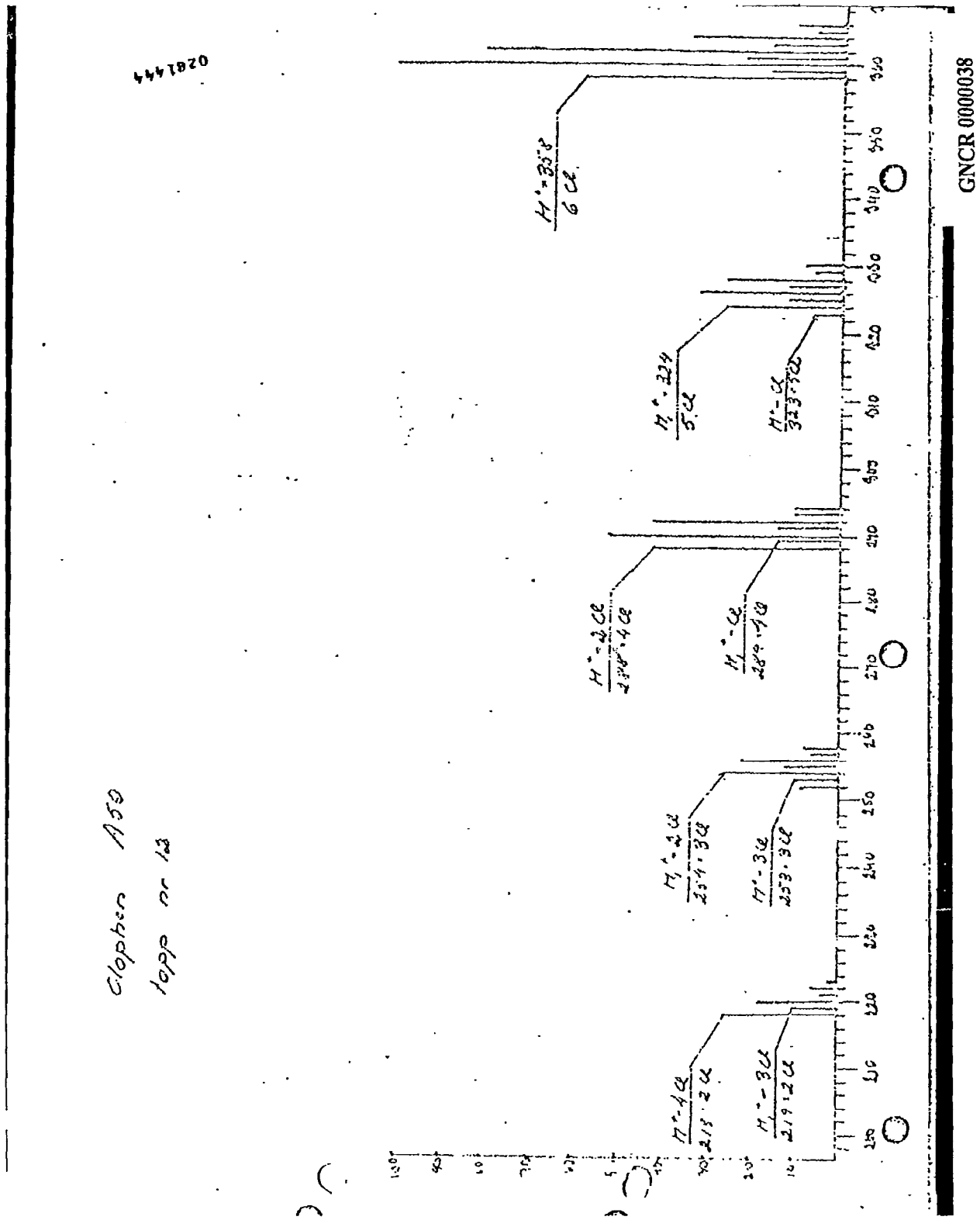
GNCR 0000037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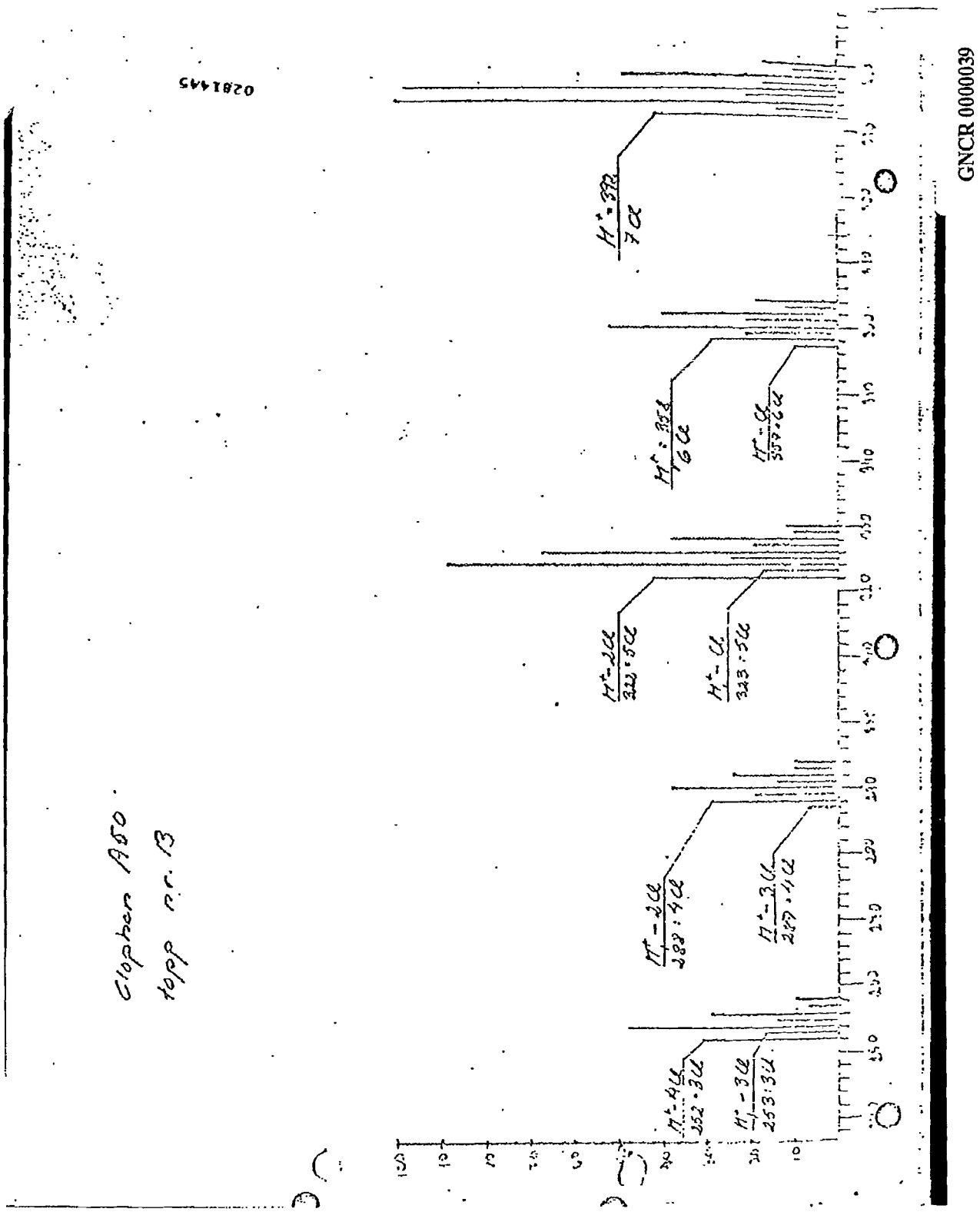
0281445
Clapham A50
topp nr. 13
GNCR 0000039

Exhibit 6

Elmer P. Wheeler, Medical Department

January 29, 1970

J. S. Barrett, [redacted]
W. B. Papageorge, [redacted]

Status of Aroclor Toxicological Studies

D. S. Cameron
Brussels

Enclosed is a copy of the reports from our consulting laboratory indicating the status of the animal toxicity studies. I have summarized the pertinent findings separately and as indicated in the table.

We have given copies of these data to one U. S. customer, the U. S. FDA and one or two other state agencies. I don't see why this information cannot be released with discretion in Britain or Europe.

Our interpretation is that the PCB's are exhibiting a greater degree of toxicity in this chronic study than we had anticipated. Secondly, although there are variations depending on species of animals, the PCB's are about the same as DDT in mammals.

We have additional interim data which will perhaps be more discouraging. We are repeating some of the experiments to confirm or deny the earlier findings and are not distributing the early results at this time.

Elmer P. Wheeler

EPW:ju

Enclosure

MONS 098480

Exhibit 7

REPORT OF A NEW CHEMICAL HAZARD

A Swedish research worker has expressed concern over the increased amounts of polychlorinated biphenyl (PCB) entering the air, presumably from industrial smoke and rubbish-dump smoke, and being absorbed by water and taken up by fish and later humans. PCB which is related to and as poisonous as DDT was detected by Mr. Soren Jensen of the Institute for Analytical Chemistry, University of Stockholm, in some 200 pike taken from different parts of Sweden, fish and fish-spawn throughout the country, an eagle which was found dead in the Stockholm Archipelago, and, in his own, his wife's and his baby daughter's hair. As the baby is only five months old her fauther concludes that she got her dose of PCB with her mother's milk.

It is not known at present how much of this substance is dangerous or even fatal. If it is comparable with DDT then the limit would be 0.5 mg per cubic metre of air - and, for comparison, the dead eagle had at least 10 times as high a concentration in its body. For purposes of elimination Mr. Jensen has obtained feathers from eagles preserved at the Swedish National Museum of Natural History since 1880 and has detected PCB first in an eagle from 1944.

In Sweden, PCB is known to be used in electrical insulations, hydraulic oils, high-temperature and high-pressure lubricating oils, paints, lacquers and varnishes, and as pigments in various plastics. It does not seem to be used as an insecticide. It is not destroyed by incineration and may enter the body directly through the skin, by breathing, or by way of food (especially fish). It is particularly harmful to the liver, and also the skin; this has been demonstrated by experiments on mice. PCB is much harder to break down than DDT and there is every reason to suppose that it is much more difficult to get it out of the system. The substance has also been detected in the air over London and Hamburg and also in seals caught off Scotland. It can therefore be presumed to be widespread throughout the world.

NEW SCIENTIST 15 December 1966

Exhibit 8

FROM: W. H. Richard - Research Center

DATE: March 6, 1969

SUBJECT: AROCLOR WILDLIFE ACCUSATIONS

REFERENCE:

TO: E. Wheeler - EWHEE

cc: H. Bergen HBERG
J. Springate JSPRI
W. Schalk WSCHA
D. Olson DOLSO
R. Kelly RKELL
J. Garrett JGARR
P. Hodges PHODG
P. Park PPARK
R. Keller JFQ
E. Tucker JFQ

Risebrough in a recent paper "Nature", Vol. 220, Dec. 14, 1968, has attacked chlorinated biphenyls in three ways:

(1) a pollutant - widely spread by air-water; therefore an uncontrollable pollutant.

(2) a toxic substance - with no permissible allowable levels causing extinction of peregrine falcon by induced hepatic enzymes which degrade steroids upsetting Ca metabolism leading to reproductive weakness, presumably through thinner egg shells.

(3) a toxic substance endangering man himself; implying that the peregrine falcon is a leading indicator of things to come.

As outlined in Science, Vol. 163, Pg. 548, Environmental Defense Fund (EDF) is attempting to write new legal precedents in conservation law by hearings and court action. In the Wisconsin case, water quality standards are at issue. "A substance shall be regarded as a pollutant if its use results in public health problems or in acute or chronic (injury) to animal, plant or aquatic life". Wisconsin is one of 7 states which now have federally approved water quality standards. According to Bern Wright, acting chief of the Federal Water Pollution Control Administration's Water Quality Standards Branch, DDT would fit the definition of a pollutant upon a showing that it is harmful to aquatic life.

These people in EDF are saying we must not put stress on any living thing through a change in air or water environment. Eagles, plant life, anything which lives or breathes. This group is pushing hard on the extension of the word harmful. They claim "enzyme inducer" activity is the real threat of DDT and PCB's and are using these arguments to prove that very small amounts of chlorinated hydrocarbons are "harmful".

Monsanto is preparing to challenge certain aspects of this problem but we are not prepared to defend against all of the accusations.

(a) Monsanto is preparing itself to identify trace ppb quantities of chlorinated biphenyls in water samples, in concentrated collected air samples, and in animal tissues. We will know whether we have been falsely identified and accused or not. We will eventually know where any pollution is taking place and the extent of the pollution.

MONS 096509

CV96-3-0440-E
DATE 04/02/01

PLFF EXHIBIT NO. 163

(b) We are not prepared to defend ourselves against the accusations made of enzyme and hormone activity, the isolation of enzymes or metabolic products, the indirect accusation of cancer, or the splitting of genes, when this accusation is made. Whether we can defend this route or not needs further discussion.

(c) Through the Industrial Bio-Test program we are to establish the long term allowable limits of chlorinated biphenyls for certain birds-fish-animals by feeding experiments, pathological examination, and tissue analysis for chlorinated biphenyls. We may be able to answer reproductive ability in some animals.

DDT has been under attack for some years because of its chlorine content, its persistent ability to be identified, and the wildlife problems attributed to it. We will still be under the same attack by the mechanisms listed in (b) even though we might establish safe operating limits for humans and certain animals.

Where does this leave us?

Under identification and control of exposure - we will be able to identify and analyze residues as well or better than anyone in the world. We will probably find residues other than DDT and PCB's. We will probably wind up sharing the blame in the ppm to ppb concentration level.

We can take steps to minimize pollution from our own chlorinated biphenyl plants, we can work with our larger customers to minimize pollution, we can continue to set up disposal and reclaim operations. We can work for minimum exposure in manufacture and disposal of capacitors, transformers and heat transfer systems, and minimize losses for large hydraulic users.

But, we can't easily control hydraulic fluid losses in small plants. It will be still more difficult to control other end uses such as cutting oils, adhesives, plastics and NCR paper. In these applications exposure to consumers is greater and the disposal problem becomes complex. If chlorinated biphenyl is shown to have some long term enzyme or hormone activity in the ppm range, the applications with consumer exposure would cause difficulty.

Risebrough has taken known Aroclor samples and claims to have evidence of enzyme and hormone change. Here there is no question of identification. Either his position is attacked and discounted or we will eventually have to withdraw product from end uses which have exposure problems. Since Risebrough's paper in "Nature", Dec. 1968 has just been published, it is timely, perhaps imperative, that this paper and its implications be discussed with certain customers. This is a rough one because it could mean loss of business on empty and false claims by Risebrough.

Well prepared discussions with Ind. Bio-Test, Monsanto biochemists, the medical and legal departments must take place now. The

position of DDT manufacturers should be determined as a guide. We are being accused of the same things attributed to DDT.

I have written this memo to clarify some of the issues. May I please have comments.

Thanks,

W. R. Richard

ms

Att.

Exhibit 9

Monsanto

FROM (NAME & LOCATION) W. R. Richard - Research Center

DATE September 9, 1969

SUBJECT DEFENSE OF AROCLOR - F. FLUIDS

REFERENCE

TO : E. Wheeler - EWHEE

cc P. Hodges PHODG
M. Farrar Res. 1
H. Bergen HBERG

General Policy

Make the Govt., States and Universities prove their case, but avoid as much confrontation as possible. Comply and work with public officials to meet or exceed requirements ahead of time. Adverse publicity and competition are the real weapons.

Analytical for Aroclor { In Air - Which Aroclors are present? Where? / In Water - Which compounds interfere? / In Animals } Govt. Agencie

Keep track of how much contamination - which sources.

Prove Bioharmful - Let Govt. prove its case, on case by case basis

Monsanto Visit-Govt. Biolabs - in search of toxicological experiments and evidence vs. Aroclors to keep up with progress.

Monsanto Prove Bioharmless - Limited work at Ind. Bio-test -

"Safe" toxic level for { man / mammals via / fish } { Rats / Chickens / Fish }

Seek evidence of Biodegradation
Question evidence against us.
Question shrimp toxicology especially other toxic chemicals.
If Aroclor bad, others must be worse.

Probable Outcome

We can prove some things are OK at low concentration. Give Monsanto some defense.

We can't defend vs. everything. Some animals or fish or insects will be harmed.

Aroclor degradation rate will be slow. Tough to defend against. Higher chlorination compounds will be worse than lower chlorine compounds.

Therefore we will have to restrict uses and clean-up as much as we can, starting immediately.

DSW 014256

Therefore we will have to work for alternate products in end use applications; for Aroclor production facilities.

Clean Up Aroclors and substitute products where necessary and when required, before threats of publicity and competitive activity overwhelm us.

Water Pollution seems to be first issue

Aroclor product is refractive, will settle out on solids - sewerage sludge - river bottoms, and apparently has a long life.

Florida or Gulf Coast - Aroclor 1254 - Aroclor 1260 present issue.

40-200 ppb - causing problem at Pensacola (Monsanto) in plant effluent-causing " with shrimp.
- can't risk shut-down of plant.

Federal and State can extrapolate to other plants in Gulf area.

San Francisco - Aroclor 1254 and 1260

Reported Aroclor to be present in San Francisco Bay.

Reported to be thin egg shells in birds -

Lot of screaming -

Great Lakes Warf studies on DDT

Aroclor 1254 will be found!

Aroclor 1242 will be found?

Air Pollution - Possible spread - but less of an issue right now.
Analytical work more difficult.

Direct Contact with Product

Doesn't seem to be an issue - except for food heat transfer.

We don't believe Aroclor is being used as carrier for insecticide - sprayed around -

We are not positive but most uses are "closed" systems or products used in solid plastics, or adhesives, or sealants.

F. Fluids	Possible Pollution by Customers Plant Operation	Possible Pollut... by Customers Pro...
Product		
Hydraulic Fluids	Yes, leakage external	Possible - See Johnson Motors Castings.
Air Compressor Fluids	Yes, leakage external	Leakage into produ...
Heat Transfer	Yes, leakage external	Leakage into produ...
Capacitor Fluids	Yes, leakage from plant - Scrap materials.	In product but closed for end use
Transformer Fluids	No, Should be clean. Yes, Reworked transformers	In product but closed for end use

* Capacitors can go to land fill dumps. Probably not burned, in Al containers.

** Need to take care of Aroclor in discarded transformers. Product could be drained and reworked.

Probable Conclusions

Hydraulic Leakage - Product could be caught at machines but will take a lot of clean-up work with customers. - Will have to have replacement product - with less-sensitive components. Work from this base on clean-up to prevent more pollution problems.

Air Compressor Fluids "

Hydraulic Fluids Must expect "shrimp" experiments, West Florida State, to be "aired" sometime soon; next few months.

This will lead to bad publicity and competitive action vs. all Pydrauls.

We will have to try to confine to Aroclor 1254 and Aroclor 1260.

We will have to take action before that time.

Gulf Coast -

Action W. Richard	Be able to replace Aroclor 1254 and Aroclor 1260 in Pydraul AC and 625 in 2 month's time before Nov. 15, 1969.
Fallon/ Richard	Have trial product in hands of Gulf Coast accounts and distributor before Dec. 15.
Fallon	Suggest possible buy of "all phosphate" ester from Food Machinery. Use this as one trial fluid MCS___ for insurance.
Richard/	Suggest possible substitution of Aroclor 5442 for Aroclor 1254 in hydraulic and compressor blends. E. Wheeler judges lower order of toxicity and solubility for 5442 series. Have to test product in pump test for deposits.
Fallon/ Richard	Suggest field trials of our own all-phosphate ester.
Fallon/ Kuhn/ Kountz	Work with large customers to clean-up streams. Bring in Findett as mfg. partner in the recycle business. Get money out of recycle operations.

Inland-Waterways-

Wheeler/ Richard	Be close enough to Great Lakes studies to judge situation. Are there animals which are being affected by the concentrations found?
Richard	Be prepared to replace Aroclor 1254 and Aroclor 1260 in 4 months in hydraulic fluids and in air compressor fluids.
Richard	Be prepared to replace all Aroclor 1242 or 1248 in 6 months in hydraulic fluids. This means replacement of Pydraul 312 series, and control of sale of Aroclor 1248 to other hydraulic accounts such as Cities Service and Mobil.

DSW 014259

Heat Transfer

Fallon/ Roush/ Kountz	Systems will have some leakage depending strongly on engineering and maintenance. Need to work with customers on clean-up.
Fallon/ Roush	Need to replace FR especially in food or sensitive product areas where the product is getting into water. See dish washer compounds. See letter E. Wheeler to T. Fallon.

We have possible replacement products in Therminol 55.
Therminol 66.

Action	
Kuhn	Try to assure adequate production of Therminol 66 in face of decreased Aroclor production. H_2 and terphenyl supply may become short.
	Switch customers to Therminol 55 or Therminol 66 ahead of pollution problems in customers plant.
	Work with customers on plant and dumping practices.
Kuhn/ Fallon	Findett already set up to rework. Need to make them a manufacturing arm. We get sale of recycle-rework fluid.

Capacitor Fluids		Capacitor products
	Capacitor plants have re-purification and recycle systems but up to 5% of product can be lost by poor plant producers and off-quality material.	Enclosed in Al or stainless steel for 5 to 25 year period.
Mkt. Benignus/ Bryant		Will ultimately have to dispose of capacitor products.
Eng.-Kountz/ Mfg-Hodges	5% of production could be 1M lbs/year. This is a big loss for the type of pollution we are trying now to guard against.	Recommend we try to save this product for a time.
Action	Monsanto must start to work with capacitor people to clean up plant practices. We have set-up to accept material for rework into hydraulic fluid but this relocation is not a satisfactory solution. Material must be reworked to electrical grade or destroyed, whichever is more economical. Must start now to get control of off-grade material.	Recommend replacement of future Aroclor business with other products. Have 2 years.
Eng.,TSD-Plant Pollution Control		
Hodges/ Kountz		

Action	Monsanto must help plant clean-up of customer plants decantation, coalescing, adsorption, disposal of adsorbent or recycle of adsorbents. Monsanto badly needs "know-how" for clean-up.
	Monsanto should seek Govt. contract money for clean-up research, (See MRC R. Binning, D. Nelson)

Transformers	Transformer Plant can operate in a clean, efficient manner with recycle of off-grade Aroclor.	Product transformer can remain closed s no exposure for 35
Action Benignus/ Bryant	Should advise disposal of filter element materials so as to minimize chance of water pollution. Incinerate or dispose.	
	Reworked transformers pose a threat if the Aroclor is dumped into a water stream.	Should try to retai business by clean-u by education of cus tomers.
Action Benignus/ Bryant	Should try to minimize chance of dumping "old" fluid by re-working and by educating co. shops and collecting product for rework or disposal.	
	Dalton is set up in England to rework electrical grade fluid.	
Kuhn/Kountz Findett?	Need rework facility here + disposal scheme.	

Monsanto Plants

The Dept. of Interior and/or State authorities could monitor plant outfall and find ppm of chlorinated biphenyls at Krummrich or Anniston anytime they choose to do so. This would shut us down depending on what plants or animals they choose to find harmed.

Action - Take steps to see that every precaution is taken to prevent Aroclor entering water streams. Try to reduce to ppb level.

in progress

P.Hodges-TSD Engrg.-Kountz — Seek a Govt. contract on adsorption and incineration cycles - MRC.

Take samples of streams and river water and mud evidence for before and after clean-up. Samples can be stored for further analysis if we can't keep up current with analytical determinations.

Apply Monsanto clean-up methods to customer plant clean up equipment and procedures.

Action - Engrg. & Mfg. Kountz and Kuhn

Evaluate liquid incinerators vs. solids handling incinerators for disposing of Aroclor and pentachlorophenol wastes. I estimate Aroclor disposal at 1-4M lbs/year, exclusive of cleaning up river bottoms or outfall bottoms.

Hydraulics	20% of 4M lbs	800,000 lbs
Heat Transfer	10% of 2M lbs	200,000 lbs
Capacitors	5% of 20M	1,000,000 lbs
Transformers	5% of 15M	750,000 lbs
		2,750,000 lbs

Central Eng. & Mfg TSD

Kountz & Kuhn

Set up an incinerator to handle Aroclor disposal - preferably one which will handle solids such as muds - slurries as well as liquids. Have in operation within 12 months. Ideally have incinerators available different sections for disposal.

Possible help from MRC

Chronic Toxicity Studies - Ind. Bio-Test

Wheeler Keller Ind.Bio-Test

Continue studies to establish FDA type limits of toxicity on Aroclor 1242, Aroclor 1254 and Aroclor 1260.

Rework with R. Keller-S. Tucker the number of samples which are to be analyzed for Aroclor in tissue. Try to see if Aroclors are changed metabolically. Does concentration level off, decline if feeding is stopped?

Institute studies against the most limiting biological parameters. If shrimp are the most limiting species for Aroclor levels of toxicity, then we will have to have biological studies on these species to confirm or deny adverse findings.

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Biodegradation Studies

Swisher — Set up rate of biodegradation studies with Inorganic Div. on
- Aroclor 1242 vs. Aroclor 1254
- Aroclor 5442 vs. Aroclor 5460
- Chlorinated diphenyl ether
- Chlorinated paraffin vs. chlorinated naphthalene
- Chlorobromo Aroclors 1242 and 1248

Baxter
Lidgett
MCL — Contact Baxter and Lidgett at MCL regularly for results on Aroclor degradation. They are reported to be moving on laboratory experiments.

Establish contact with chlorophenol degradation studies of Cellu-Chem Group.

WRR

W. R. Richard

WRR:ms

Biodegradation Studies

Set up rate of biodegradation studies with Inorganic Div. on Aroclor 1242 vs. Aroclor 1254
Aroclor 5442 vs. Aroclor 5460
Swisher Chlorinated diphenyl ether
Chlorinated paraffin vs. chlorinated naphthalene
Chlorobromo Aroclors 1242 and 1248

Baxter Lidgett MCL Contact Baxter and Lidgett at MCL regularly for results on Aroclor degradation. They are reported to be moving on laboratory experiments.

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WRR

W. R. Richard

WRR:ms

Exhibit 10

CONFIDENTIAL

MINUTES OF AROCLOR "AD HOC" COMMITTEE

First Meeting

Date: September 5, 1969

Present: M. W. Farrar
P. B. Hodges, Secretary
E. V. John
W. R. Richard
E. P. Wheeler, Chairman

Objectives: (Agreed to by the Committee)

Submit recommendations for action which will:

1. Permit continued sales and profits of Aroclors and Terphenyls.

2. Permit continued development of uses and sales.

3. Protect image of Organic Division and of the Corporation.

Background Discussion of Problem:

1. Agreed that we should concentrate on Aroclor 1254 and 1260. Aroclor 1242 has not yet been incriminated for these possible reasons:

   a. Nature of uses of 1242 minimizes environmental contamination.

   b. It may degrade biologically.

   c. Unless analytical techniques are performed carefully, 1242 can be destroyed by oxidation during the analyses.

2. PCB has been found in:

   a. Fish, oysters, shrimp, birds.

   b. Along coastlines of industrialized areas such as Great Britain, Sweden, Rhine River, low countries, Lake Michigan, Pensacola Bay, in Western wild life (eagles). It may be a global contaminant.

3. PCB has been tied to DDT in effects on disappearance of wild birds which have fish diets. Ratio of PCB to DDT has been about 40-50:1 generally. Dr. Reisboro reported almost 1:1 ratio. PCB may be contributing to or exaggerating the effects of other chlorinated aromatics.

MONS 030483

4. Sample acceptance from the numerous researchers was discussed. This has been done on a limited basis. Our corroboration of testing of their samples adds to our knowledge and demonstrates a willingness by Monsanto to help define the problem, but it is expensive and also tightens any possible legal cases against us--it rules out possibilities that Aroclors are not involved.

5. Toxicity levels:

Aroclors have been shown to be safe for man in reasonable exposure concentrations. We are testing 100 ppm in diet of rats and dogs on a rule-of-thumb basis that 1/100 of toxicity level is safe and 1 ppm is probably the upper limit in total diet.

"Allowable levels" are probably lower than DDT. The worst example to date is the test at Pensacola where 5 ppb was found to be toxic to shrimp in 18 days exposure.

One problem we are facing is to keep the "safe level" (?) for shrimp from being applied to e.g. Lake Michigan where more tolerant fish species probably exist. We need to show the safe level in shrimp, clams, oysters and several species of fish.

Many toxicity studies on PCB are underway and it was agreed to be desirable to keep contact with all laboratories which have requested Aroclor samples. One-half to two-thirds of the sample requests have come from state labs (who would let us know what they are doing) and about 1/3 have come from universities (who may give us the "brush-off"). Question of who should call on the laboratories was not resolved.

6. Escambia River Problem:

For a clearer understanding of the general problem, the situation at Pensacola was reviewed. From a relatively negligible discharge of 1-3 gal/day into a large river, 1/4 mile downstream levels of 42 ppb in water and 476 ppm in mud were found. Although use of Aroclor was halted immediately, we can expect the water contamination to continue for a lengthy period by leaching from the contaminated mud. No downstream samples have yet been taken to measure the decrease in contamination (as of 9/5/69).

7. Problem in Producing Plants:

P. Hodges reviewed what was being done to stop gross losses at Anniston and at WGK. Basically, the work to date consists of stopping or trapping any sewering of free Aroclor with return to process or land fill disposal of the trapped Aroclor. This will reduce levels in plant effluents to below solubility ranges, particularly as we move to install traps (or sumps) back into the waste source points where flows are small and as yet undiluted by Aroclor-free waste streams. The question of exactly how far to reduce (how much money to spend) is not yet clear and expenditures to date have been comparatively small. It was agreed that, until the problems of gross environmental contamination by our customers have been alleviated, there is little object in going to expensive extremes in limiting discharges from the plants.

One problem that has been interfering with logical development of our plant Aroclor waste reduction programs has been delays in obtaining analytical results from in-plant and ex-plant sampling. It was agreed that additional help was necessary in Dr. Tucker's lab but no specific actions were proposed. In addition to in-plant work, the plants are sampling the receiving streams.

Air pollution reduction has not been considered by the plants to date except as incidental prevention of product contamination during tank car and drum loading operations. Long range (1-2 year) improvements at Anniston are planned to reduce product contamination (and air emissions) in car loading operations. It was agreed that a comprehensive air sampling and testing program would be very expensive and is probably not justified at this stage of the problem.

8. Environmental Contamination by Customers:

Our in-plant problems are very small vs. problems of dealing with environmental contamination by customers. In one application alone (highway paints), one million lbs/year are used. Through abrasion and leaching we can assume that nearly all of this Aroclor winds up in the environment.

Because the rate of natural (bio-degradation) is very low, other degradation must destroy PCB equal to the rate of environmental exposure in order to avoid build-up of contamination.

A general discussion was held on philosophy of controlling sales or working with customers to prevent pollution by PCB.

Action Planned:

Each member of the group will submit to the other members for consideration possible ideas and programs to help accomplish the overall objectives set by the Committee. Following review of the suggestions, the Committee will meet again at an early date to be arranged by the Chairman.

P. B. Hodges
Secretary

:ju

Exhibit 11

CONFIDENTIAL

Date: October 2, 1969

Subject: REPORT OF AROCLOR "AD HOC" COMMITTEE

To: Howard S. Bergen, Jr.
James E. Springate

From: M. N. Farrar
P. B. Hodges, Secretary
E. V. John
W. R. Richard
E. P. Wheeler, Chairman

CONTENTS

Summary of the Problem

On August 25,

OBJECTIVES

At a meeting of business group directors of Function Fluids and Plasticizers with Organic Division and Corporate Staff members, an "ad hoc" committee was appointed to prepare a resume of the situation concerning the environmental contamination through the manufacture and use of polychlorinated biphenyls (Aroclors).

The objective of the committee was to ~~prepare~~ recommended action that will:

1. Protect continued sales and profits of Aroclors;

2. Permit continued development of new uses and sales, and

3. Protect the image of the Organic Division and the Corporation as members of the business community recognizing their responsibilities to prevent and/or control contamination of the global ecosystem.

PROBABILITY OF SUCCESS

The committee believes there is little probability ~~(illegible)~~ that any action that can be taken will prevent the growing incrimination of specific polychlorinated biphenyls (the higher chlorinated--e.g. Aroclors 1254 and 1260) as nearly global environmental contaminants leading to contamination of human food (particularly fish), the killing of some marine species (shrimp), and the possible extinction of several species of fish eating birds.

Secondly, the committee believes that there is no ~~possible~~ practical course of action that can so effectively police the uses of these products as to prevent environmental contamination.

There are, however, a number of ~~possible~~ actions which must be undertaken in order to prolong the manufacture, sale and use of these particular Aroclors as well as to protect the continued use of other members of the Aroclor series.

The ultimate that can be expected is the continued use (less than 5 Chlorines) of the lower chlorinated biphenyls and the chlorinated terphenyls in applications amenable to such control that there is practically zero losses to the environment. In the interim we would hope to establish by appropriate research efforts "tolerance" or safe levels for particular Aroclors in the environment.

- The identification is ~~possi~~ positive
- Toxicity towards certain species is high.
- Persistance is high.
- Likelyhood of natural origin or degradation is remote.

RECOMMENDATIONS

OK 1. In view of legal and moral considerations, notify all Aroclor 1254 and 1260 customers of environmental contamination problem. + advising customers.

3, ~~2.~~ Consult with appropriate federal agencies' headquarters in Washington to determine current status of concern and to inform appropriate individuals therein of Monsanto's research and control efforts.

4, ~~3.~~ Personally contact all governmental and university laboratories which have requested Aroclor samples and indicated interest in the environmental contamination problem.

2, ~~4.~~ Reduce losses of Aroclors in liquid wastes from Monsanto plants to ~~absolute~~ minimum. Goal ~~0~~ to 25 ppb ~~10 parts per billion~~. For 1254 & 1260.

5. Determine extent of atmospheric losses from Aroclors from Anniston and WGK Plants and develop plans for control.

6. Analyze in Organic Division laboratories (or by contract) selected appropriate samples from:

   a. Environment of Anniston and WGK Plants.

   b. Monsanto products where contamination is possible.

   c. Agencies and/or laboratories attempting to pinpoint specific sources of contamination.

   d. Customer plants' environments.

   e. Research efforts involved in biological studies--i.e. animal, bird and fish toxicity studies and biodegradation studies.

7. Expand analytical capabilities in conjunction with items 5. and 6. above.

RECOMMENDATIONS (Continued)

8. Assign one individual from the division full-time for three to six months to coordinate division and Corporate Staff department efforts.

9. Establish special budgetary account to allow implementation of these recommendations and the continuation of the toxicological research effort now underway and continuing until June, 1971.

BASIS FOR RECOMMENDATIONS

1. Notification of All Customers

On ~~September~~ Feb. 24, 1969 the San Francisco Chronicle published a "scare" story following an interview with Dr. Robert Risebrough of the University of California. The latter had recently published in Nature the finding of polychlorinated biphenyls in fish, birds and eggs in the California coastal areas.

On March 3, 1969, the Functional Fluids group sent a letter to the 31 major Aroclor customers in the transformer and capacitor applications. The letter included a copy of the Chronicle story and a Monsanto statement concerning the situation. This was intended to announce to these customers that the polychlorinated biphenyls might be in trouble and implied that the customers should make every effort to prevent loss of these materials to the environment. There has been subsequently some follow-up with at least General Electric and Westinghouse.

It has been recognized from the beginning that other functional fluid uses could lead to losses of the Aroclors to liquid waste streams from the customers' plants. Losses could occur from spills, unusual leakage of large volumes and daily losses of smaller volumes.

It has also been recognized that there could be vapor losses but it has been felt that these were perhaps of less significance than the vapor losses in plasticizer applications. The concern for vapor losses rises from the published proposed theory that even minute quantities of vapors are eventually transferred to the water environment and accumulated therein.

Another possible source of air environmental contamination is the eventual destruction of materials which have Aroclors in them. Of particular significance might be the burning or partial incineration of waste or used products containing the Aroclors.

BASIS FOR RECOMMENDATIONS (Continued)

As the alarm concerning the contamination of the environment grows it is almost certain that a number of our customers or their products will be incriminated. The company could be considered derelict, morally if not legally, if it fails to notify all customers of the potential implication.

A case in point is the recent determination (mid-~~August~~ sept.) that milk to be marketed by the Maryland Cooperative Milk Producers, Inc. in Baltimore was contaminated with polychlorinated biphenyls. The source of the PCB's was isolated to six dairy herds in Martinsburg, West Virginia. Investigation by the Producers Association is continuing but to our knowledge the specific source of the PCB has not been pin-pointed.

When the Aroclors were indited as causing poisoning in cattle in the mid-1950's, chlorinated naphthalenes were eventually identified as the causative agent. The naphthalenes were used in greases or lubricants for cattle feed machinery and had contaminated the animal food. (Members of the Medical Department have been told that the Texas company "bought" 6,000 head of cattle around the country as a result of this incident. It is not known whether or not the suppliers of the naphthalenes to Texaco were brought into the settlement.) Are our customers selling grease or lubricants containing Aroclors that are now responsible for the milk contamination?

In the plasticizer use area, the Aroclors may be used in rubber based paints or surface coatings. The uses for these surface coatings include the interior walls of potable water supply storage tanks in some communities. In Europe we have been told that similar paints are widely used for swimming pools. In spite of the low degree of solubility of the PCB's in water, there are sentiments among the European scientists (and our PCB competitive manufacturers) that such uses may be sources of pollution.

Other customer applications or uses which could be suspect include highway marking paints, ~~and~~ any of the oil and/or grease lubricant applications, caulking compounds - sealants,

BASIS FOR RECOMMENDATIONS (Continued)

2. Consultation with Federal Agencies

In August of 1968 when the current effort related to this problem got underway, the scientists at the U. S. Department of Interior, Fish and Wildlife Laboratories at Paturent, Maryland were visited. In the six to twelve months that the laboratory had been looking for PCB residues, they had identified such compounds in dead eagles as well as marine birds. At that time they did not report positive findings in fish, shell fish or other marine organisms. We know that their efforts have been continuing at an accelerated rate but the laboratory has not been revisited to learn of current developments.

The U. S. Food and Drug Administration in Washington called Dr. Kelly in June to report that the State of Georgia had found PCB's in milk (we had in April supplied samples of our Aroclors to the Georgia State Department of Agriculture Laboratories in Atlanta).

The analyses of milk from the Maryland co-op mentioned in 1. above were performed by an FDA laboratory.

On Friday, September 26, we were asked to send samples to the Atlanta Toxicological Branch of the FDA and to the Residue Chemical Branch Division of Pesticides, FDA in Washington. The stated reason for the request was for these laboratories to determine the "acute toxicity" of Aroclors 1254 and 1260.

In the past year we have had request for samples from five or six of the regional laboratories of the Federal Water Pollution Control Administration--an agency within the U. S. Department of Interior. We have not had an opportunity to follow-up with these laboratories as to their interest or concern.

In August a laboratory of the Bureau of Commercial Fisheries, Department of Interior, at Pensacola, Florida, reported finding PCB's in the river below our Pensacola Plant. Subsequently, they reported that 5 parts per billion of Aroclor 1254 killed baby shrimp in 18 days. There has been no follow-up by St. Louis based personnel since our Pensacola Plant discontinued the use of Pydraul AC.

BASIS FOR RECOMMENDATIONS (Continued)

Appropriate individuals in the parent federal agencies should be visited to determine their current activities and concern and, secondly to make these agencies aware of Monsanto's interest, research and control efforts.

3. Contact with other Governmental and University Laboratories

In addition to the above, Monsanto has provided samples of the Aroclors to 30 or 40 other governmental and university laboratories or scientists. It would be prudent and appropriate for someone from Monsanto to personally follow-up the supplying of the samples and determine the status of the efforts of these groups. For example, the State Department of Agriculture Laboratory in Hartford, Connecticut reported in July that they had found PCB in fish off the coast of Connecticut. This led to two articles in the Hartford Times and a five minute radio program through a syndicated outlet of 108 radio stations.

4. Losses from Monsanto Plants

Efforts to reduce the losses of Aroclors in liquid wastes from the Anniston and WGK Plants are completed or underway. It is impossible to establish a limit as to what can be discharged "safely". Investigation has shown that the waters in receiving streams below the Anniston Plant contain significant (parts per million) concentrations of PCB. More ominous perhaps is the fact that sediment in the bottom of these streams miles below our plants may contain up to 2% Aroclor.

To prepare for the eventual publication in the press of the discharge of PCB's in Alabama and to the Mississippi River, a significant effort must be made to determine the present levels of contamination and more importantly, determine the levels of contamination as "clean up" procedures begin to show an effect.

The incident at the Monsanto Plant at Pensacola indicates that all Monsanto Plants using Aroclors should be made aware of the potential problem and efforts made to eliminate any losses. The significance of "any losses" may be related to the one to three gallons per day which was being lost at the Pensacola Plant.

BASIS FOR RECOMMENDATIONS (Continued)

Hopefully research efforts will indicate that a "safe level" of losses would be higher in fresh water streams not adjacent to coastal estuaries. At the present time we know of no claims that the PCB's are "destroying" fish.

5. Atmospheric Losses at Anniston and WGK

The determination of atmospheric losses for our Aroclor manufacturing plants will be more tedious and time consuming than in the case of liquid wastes. We will never be prepared to discuss intelligently potential problems of our customers where there may be atmospheric losses until we have some data on our own plants. This is particularly true if we ever expect to recommend to our customers measures for control of atmospheric losses.

6. Analytical Capabilities (a. through e. inclusive)

In each of the recommendations 2. through 5. above, there is the implication that Monsanto's best interest could be served by appropriate sampling and analysis. In connection with any of the governmental and other laboratories, we must accept their reported analytical results or in specific instances offer to run duplicate analyses to confirm for ourselves the validity of the reported results.

The committee agrees that to perform analyses that would confirm all of the reported findings represents an unreasonable cost in terms of personnel and facilities. At the same time there appears to be no alternative to the acceptance in the last three months that confirmation analysis in selected cases should be done. This has led to an accumulation of a backlog of samples which need attention. Delays in analysis are occurring because of shifting priorities for samples as they are received or as they have been retained.

A case in point is the delay in analyzing thirteen samples from the Inorganic Division. Samples were submitted following the finding that five of five commercially available electric dishwashing compounds analyzed showed the presence of PCB's. The Inorganic Division can not exonerate the products it sells to the detergent manufacturers until it has some data showing whether or not Monsanto supplied materials are contaminated. In the meantime Inorganic Division Quality Control has

BASIS FOR RECOMMENDATIONS (Continued)

suggested to its Division Engineering that future designs for making detergent components insure that the use of Aroclors will not permit contamination. Secondly, it is obvious that the Division cannot approach its detergent manufacturing customers about their potential problem until the above data indicate that "our own skirts are clean".

This week it was agreed that milk and water samples from the Maryland co-op in Baltimore should take precedence over other samples which had been scheduled.

In summary, the committee believes there will be a growing number of samples from the following:

a. Environment of Anniston and WGK Plants.
b. Monsanto products where contamination is possible.
c. Agencies and/or laboratories attempting to pin-point specific sources of contamination.
d. Customer plants' environment.
e. Research efforts involved in biological studies--i.e. animal, bird and fish toxicity studies and biodegradation studies.

7. Expansion of Analytical Capabilities

The recommendation to expand the analytical capabilities is a necessity in view of the preceding recommendations.

8. Assignment of Full-Time Effort

Up to this time the coordination of the Division effort has been principally the responsibility of W. R. Richard and E. P. Wheeler with support from R. E. Keller and Cumming Paton. Each of these individuals has other responsibilities to the extent that, although the Aroclor problem may have been a predominant issue, other areas of interest could not be slighted.

The committee believes that the problem is of sufficient seriousness to warrant the full concentration of at least one individual for the next three to six months. Those who have been involved up to this point would obviously continue in their

BASIS FOR RECOMMENDATION (Continued)

supporting efforts where the individual's background or expertise would make it appropriate. For example in connection with the follow-up with the federal agencies in Washington, Dr. Kelly would expect to be present for any contact with USFDA officials.

Other members of the Medical Department would be made available for contacts with the pollution control agencies or those laboratories or universities where toxicity appears to be of interest or concern.

Certainly Dr. Keller and Scott Tucker should accompany anyone making visits where the specific question of analytical techniques was to be discussed.

This still leaves a number of man months to be devoted to the other laboratories or agencies which have up to this point not made their specific interest known.

Equally if not more important is the effort which must be made relating to the contacts with customers. The committee does not believe that this can be handled by district marketing representatives without supplying such "local" individuals with a complete background of the problem.

9. Budgetary Considerations

The committee recognizes the restrictions placed on those currently involved by mandates to operate within normal or proposed reduced budgets. It should be clear, however, that the product groups, the Division and the Corporation are faced with an extraordinary situation. There can not be too much emphasis given to the threat of curtailment or outright discontinuance of the manufacture and sales of this very profitable series of compounds. If the products, the Division and the Corporation are to be adequately protected, adequate funding is necessary.

Exhibit 12

PCB PRESENTATION

TO

CORPORATE DEVELOPMENT COMMITTEE

I. INTRODUCTION:

We are here today to acquaint you with the PCB (Aroclor) pollution problem and to secure your guidance and approval on a recommended plan of action.

The problem is that Certain PCB's have recently been identified by various scientists along with DDT in fish, birds, and other wildlife.

From the standpoint of reproduction, the PCB's are highly toxic to birds. In a few moments, Elmer Wheeler will describe the problem in detail.

Our objective is to describe for you the basic problems, the issues involved, review alternative courses of action, and suggest an action plan program for your approval.

This is a serious matter, not only from the pollution viewpoint, but also because of the $22 M worldwide customer business involved with resultant gross profits of $10 M and a net investment of approximately $9 M. In addition, there could be possible adverse legal and public relations problems leveled against Monsanto.

Our Agenda will be as follows:

PCB AGENDA REVIEW

I. INTRODUCTION

II. THE PROBLEM
- DEVELOPMENTS INCRIMINATING PCB's
- COMPLEXITY OF IDENTIFICATION
- NATURE OF
- SERIOUSNESS

III. LAW DEPARTMENT VIEWPOINT AND RECOMMENDATIONS

IV. EFFECT ON MONSANTO AND ALTERNATIVES

V. FUNCTIONAL FLUID BUSINESS GROUP DISCUSSION
- MARKETS, USES
- SOURCES OF POLLUTION
- CUSTOMER EFFECT

VI. PLASTICIZER BUSINESS GROUP DISCUSSION
- MARKETS, USES
- SOURCES OF POLLUTION

VII. RECOMMENDED ACTION PLAN

VIII. SUMMARY

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By way of introduction, the Organic Division and the Medical Department has been actively engaged for the last 18 months in developing facts and knowledge on this subject by personal visits to Universities and Industrial test laboratories, other worldwide producers, and other industrial collaborators, as well as keeping abreast of all literature and news sources on the subject as well as funding a toxicological and analytical test program in excess of $200 M. We established an Ad Hoc Committee of both Business Groups and Medical which recently issued a report - much of which will be discussed today. We have learned a lot, but there is much yet to learn as you will hear.

What are PCB's? They are polychlorinated biphenyls - better known to us as Aroclors. The next slide will quickly re-familiarize you with our Aroclor business.

MONSANTO WORLDWIDE AROCLOR BUSINESS

POUNDS/YEAR	104 M (70 M in Functional Fluids 34 M in Plasticizers)
SALES/YEAR	$22 M ($16 M in Functional Fluids $ 6 M in Plasticizers)
GROSS PROFIT/YEAR	$10.0 M ($7.5 M in Functional Fluids $2.5 M in Plasticizers)
GROSS INVESTMENT	$13 M ($8.8 M net investment)
ROI	10.5%
WORLDWIDE M/I	62%
MONSANTO PRODUCTION LOCATIONS:	USA (2 plants, Anniston, Alabama Sauget, Illinois)
	UK (Newport)
	JAPAN (Yokkaichi)
OTHER PRODUCERS:	Bayer, Prodelec, Caffaro, Flick, Kanegahuchi, and several Eastern European producers (all ex-USA)

ex UK

THE AROCLOR PRODUCT LINE

CHEMICAL NAME	TRADE NAME	NATURE OF MATERIAL
MONOCHLOROBIPHENYL	AROCLOR 1221	THIN LIQUID
DICHLOROBIPHENYL	AROCLOR 1232	
TRICHLOROBIPHENYL	AROCLOR 1242	OILY LIQUID
TETRACHLOROBIPHENYL	AROCLOR 1248	
PENTACHLOROBIPHENYL	AROCLOR 1254	HEAVY MOLASSES
HEXACHLOROBIPHENYL	AROCLOR 1260	THICK TAR
HEPTACHLOROBIPHENYL	AROCLOR 1262	
OCTACHLOROBIPHENYL	AROCLOR 1268	
DECACHLOROBIPHENYL	AROCLOR 1270	SOLID
TERPHENYLS	SANTOWAX	
CHLORINATED TERPHENYL	AROCLOR 5460	SOLID

There are theoretically 210 different isomers of chlorinated biphenyls.

Monsanto entered the Aroclor market in 1930 by acquiring Swan Chemical Company. The first load of Aroclor went out of Anniston, Alabama to General Electric in 1931. Since then, the market has grown to one of Monsanto's most profitable franchises. This franchise is now being threatened not by competition but by recently found pollution problems which Elmer Wheeler will now discuss.

II. The Problem (Wheeler) - see attached Appendix A

III. Law Department Viewpoint and Recommendations (French)

IV. Effect on Monsanto and Our Alternative Courses of Action

As discussed, Aroclors 1254 and 1260 -- the 5 and 6 Cl ringed biphenyls are the ones most seriously involved in the pollution problem. Both Plasticizers and Fluids Groups are involved as shown:

AROCLOR SALES

(M POUNDS)

	FLUIDS	PLASTICIZERS	TOTAL
AROCLOR 1254	1.45	5.4	6.85
AROCLOR 1260 & ABOVE	3.7	1.7	5.4
	5.15	7.1	12.25

We considered 4 alternative courses of action:

(Slide)

Alternative 1: Do nothing was considered unacceptable from a legal, moral, customer & public relations & company policy viewpoint. This is also the quickest route to being forced out of business.

Alternative 2: Go out of total Aroclor business was considered unacceptable from a Divisional viewpoint, but from a Corporate viewpoint may be necessary. ~~Only you can make that decision.~~ All Aroclor products are not serious pollutants - many degrade; there is too much customer/market need and selfishly too much Monsanto profit to go out. To go out would require a write off of Aroclor net investment of $7 MM (10¢/share) or if biphenyl included $8.8 MM (12¢/share). In addition, inventory disposition, continuing cost of utilities, and back-up capital and serious manpower & resources reallocation at Anniston.

Alternative 3: Go out of Aroclor 1254 and 1260. This was seriously considered and may eventually occur by our actions and customer actions, nevertheless, we feel that segments of this business are defensible or are so "confined" in use that specific plans of action are called for this portion. Our reasons for eliminating this alternative will become clearer as we outline our action plans.

ALTERNATIVE COURSES OF ACTION

1. DO NOTHING - JUST REACT TO LEGISLATION AND EMOTION.
2. GO OUT OF TOTAL AROCLOR BUSINESS.
3. GO OUT OF AROCLOR 1254 AND 1260 PRODUCTION
4. DEVELOP SPECIFIC ACTION PLANS "TAILORED" TO EACH BUSINESS GROUP AND EACH CUSTOMER/MARKET SITUATION TO "CLEAN UP" THE MESS.

Alternative 4: Develop specific action plans tailored to each Business Group and each customer/market situation, - was the alternative selected at this point of time and based on our knowledge from a Divisional viewpoint as making Monsanto act in the most positive, responsible way to society and our customers, as well as our interests.

However, because of the magnitude and seriousness of this problem and its total implications for Corporate Monsanto, ~~the final decision on this matter must be made by the CDC~~. Your plan your guidance and approval is needed.

V. Functional Fluids Business Group Discussion:

Aroclors are used widely in 3 of our 4 market areas in the Fluids Group:

FLUIDS USE OF AROCLORS BY MARKET AREA

AROCLOR PRODUCT	DOMESTIC MARKET AREA			TOTAL
	INDUSTRIAL	HEAT TRANSFER	ELECTRICAL	
1242	4.1	1.1	36	41.2
1248	1.2	1.0	-	2.2
1254	-	0.1	0.8	0.9
1260 & Above	0.6	-	3.5	4.1
	5.9	2.2	40.3	48.4

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SOURCES OF FLUIDS POLLUTION

APPLICATION	INTENSITY OF POLLUTION	
INDUSTRIAL FLUIDS	GREATEST	(DIRECT)
DIELECTRICS	↓	(INDIRECT CONTAINED)
HEAT TRANSFER	↓	(INDIRECT CONTAINED)
PRODUCING PLANTS	LEAST	(DIRECT)

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FLUIDS CUSTOMER ALTERNATIVES

AREA OF APPLICATION	PRODUCT OF CHOICE	CUSTOMER OPTIONS
Industrial Fluids	Pydraul 312/F-9/ A-200/Phosphate Esters/ Water Glycol	Customer could get along without us, but Pydraul 312 favored. H_2O Glycol has some pollution problems. Phosphate ester route ok at present.
Transformer	Air/Oil/Aroclor/Gas	Could drop Aroclor at sacrifice of safety, cost or size of equipment or noise level.
Capacitors	Aroclors	No immediate replacement available. Longer term - oil at expense of size and cost of efficiency and redesign of equipment.
Heat Transfer	Therminol	No option for FR liquid market. Other system possibility.
	Oil/Dowtherm/T66 T55 T77 T88	Liquid systems favored. T66 and T55 increasing rapidly in use. Oil also a pollution problem.

Customer Choices & Alternatives & Penalties:

Summarizing, some of our customers have no immediate alternative, some could change only at sacrifices of safety, or cost or various technical factors. Only in the Industrial field could the customer make an immediate conversion.

PCB Threat to Functional Fluids Business and Profit:

FLUIDS BUSINESS THREATENED

(1970 BUDGET)

PROBLEM	SALES	GROSS PROFIT
1. Confined to A-1254/ 1260 only.	$ 3.0 M	$1.36 M
2. Spreads to A-1242 and 1248		
First to: a) Industrial Fluids	$ 4.0 M	$1.6 M
Then to: b) Dielectric Fluids	$ 8.0 M	$3.8 M
Then to: c) Heat Transfer	$ 1.0 M	$ .6 M
	$16.0 M	$7.36 M

— Turn over to Jim Symington

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15 +1

VI

PLASTICIZERS (WORLD-WIDE)

	ALL AROCLORS	AROCLOR 1254/1260 TYPE
1969 SALES, DOLLARS	$ 6.0 M	$1.7 M (28%)
POUNDS	34.0 M	9.5 M (28%)
1969 GROSS PROFIT	$ 2.5 M	$0.8 M (32%)

COMMENTS: DISTINCTIONS FROM F.P.

1. Large number of direct U.S. customers - 570.
2. Customers are small: 23 direct customers - 47% A-1254/1260 sales.
3. 50% domestic A-1254/1260 sales through distributors - difficult to police.

MARKETS	1968 SALES	MAJOR AROCLOR USED
Carbonless Carbon Paper	8.8 M lb.	Aroclor 1242
Hot Melt Adhesives	5.7 M lb.	Aroclor 5460
Swimming Pool Paints	1.7 M lb.	Aroclor 1254) Aroclor 5460)
Protective Coatings	5.3 M lb.	Aroclor 1254) Aroclor 5460)
Emulsion Adhesives	1.5 M lb.	[illegible] Aroclor 1260)
Sealants	3.0 M lb.	Aroclor 1254) Aroclor [illegible])
Wax Modification	2.0 M lb.	Aroclor [illegible] Aroclor 5460)
Miscellaneous	5.0 M lb.	Aroclor [illegible]) Aroclor 1254)

COMMENTS: 1. [illegible] major customer (85% of Aroclor 1242 sold .

2. [illegible] of domestic Aroclors sold through [illegible] distributors.

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POSSIBLE CONTAMINATION SOURCES

(PLASTICIZERS)

DEGREE OF CONTAMINATION	MARKET	APPLICATION	SOURCE	IS A-1254 /1260 USED?
Most	Coatings	Marine Paints) Water tank linings)	Leaching	Yes
	Coatings	Swimming Pool Paints	Leaching	Yes
	Carbonless Carbon Paper	-	Vaporization	No
	Wax Modification	-	Vaporization	Yes
	Emulsion Adhesives	-	Contact with product via packaging. Incineration.	Yes
	Hot Melt Adhesives	-	Contact with product via packaging. Incineration.	No
Least	Sealants	Automotive Construction Joint sealants	Long-term leaching	Yes

COMMENTS:

1. Unlike fluids, Aroclor plasticizers are combined into plastics to produce the final product - therefore, far less mobile.
2. Problems such as wastes from our manufacturing plants, customers plants and and leasing of drums common to both groups.
3. Exterior protective coatings are not considered a high potential source.
4. Vaporization of Aroclors during plant processing or [illegible] product. Rain will wash vapors back to earth.

PLASTICIZER BUSINESS THREATENED

PROBLEM	SALES RETAINED*	$ G.P. RETAINED (LOST)
1. Confined to A-1254/1260 type only.	$4.3 M	$1.7 M (-$0.8 M)
2. Spreads to all chlorinated biphenyls.	$2.0	$0.6 M (-$1.9 M)
3. Spreads to all PCB's and all chlorinated terphenyls	0.0	0.0 (-$2.5 M)

*Based on 1965 prospects.

COMMENTS: Plasticizers sell Aroclor 1262/4465 which are very close to A-1254/1260 and these have been included as A-1254/1260.

RECOMMENDED ACTION PLAN

THE JOINT ACTION PLAN DEVELOPED BY THE FUNCTIONAL FLUIDS AND PLASTICIZER BUSINESS GROUPS, AND THE MEDICAL AND LAW DEPARTMENTS IS AS FOLLOWS:

1. Appoint a Project Manager - responsible for the overall management of the Aroclor pollution problem. He would be assisted by a Task Force from members of each Business Group plus Medical, Law, Engineering and Manufacturing.

2. Notify all Aroclor customers of PCB problem and relabel containers - within 60 days.

3. Clean up Monsanto plants' effluents within 12 months.

4. Develop and implement new packaging systems for Aroclor 1254/1260 - within 6 months.

5. Educate customers on need for clean-up at their plants - within 4 months.

6. Introduct to market, replacement products for Aroclor 1254/1260 - beginning 1/1/70 (Fluids), 4/1/70 (Plasticizers).

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RECOMMENDED ACTION PLAN

7. Continue and expand biodegratation test program with Aroclor series, particularly 1242, 1248 and 1254.

8. Continue toxicological test program.

9. Accelerate present analytical test program.

10. Determine feasibility and cost of eliminating 5/6 Cl_2 in Aroclors 1242 and 1248. (3/70)

11. Study incineration products. (3/70)

12. Develop business plan to offer:

    Monsanto Fluid Reclamation and Recovery with Enviro Chem (4/70). (Reclamation already underway at Findett.)

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WHAT COULD WE EXPECT FROM THIS PROGRAM?

Through this action program, Monsanto would expect to:

1. Retain or convert a good portion of our business and profits:

PROBLEMS	CONVERT OR RETAIN	$M SALES OUT OF PRESENT	ODDS OF SUCCESS
a. Confined to A-1254/ 1260.	$20.3 M	$22 M	70%
b. Spreads to A-1248 and 1242.	$10 M	$22 M	60%

2. Gain further valuable knowledge and time to:
   a. Learn more facts.
   b. Protect our position.
   c. Make further decisions regarding our program.
   d. Contribute to overall pollution knowledge.

3. Clean-up the major contributing PCB pollution factors.

4. Minimize customer complaints and hardships.

~~-2-~~ 4 23

The Program Would:

1. Cost some money.

   Est. SARE - $400-500 M

   Est. Capital - $700 M

   $1.1 M - 1.2 M

2. Expose us to continued adverse publicity and possible law suits.

3. Cause some customer discontent - but much less than an abrupt termination of production.

Exhibit 13

Monsanto

FROM (NAME & LOCATION) N. T. Johnson St. Louis

DATE February 16, 1970

SUBJECT POLLUTION LETTER

REFERENCE

TO

P. Craska - Wilmington
C. Clay - St. Louis
J. H. Davidson - Los Angeles
R. A. Damiani - Chicago
G. F. Fague - Detroit
R. A. Garcia - Akron
R. Garnsworthy - Melbourne
J. A. Heilala - Akron
R. Irwin - Houston
J. S. Pullman - New York
J. J. Roder - Chicago
R. Giles - Melbourne

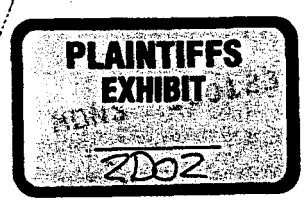
cc:

P. J. A. Marsh - Brussels
R. Enrhardt - New York
T. W. Oneson - Montreal
J. N. Haggart - Brussels
V. Morse - St. Louis
J. Brydon - Montreal
R. Graham - New York
P. G. Benignus
J. G. Bryant
D. E. Roush
J. R. Fallon
D. A. Hall
D. R. Pogue
D. F. Smith
D. A. Olson

Attached is a list of questions and answers which may be asked of you by customers receiving our Aroclor-PCB letter. You can give verbal answers; no answers should be given in writing. If the customer asks a question you can't answer or if he wants an answer in writing, then send his questions to me and we will answer from here.

We want to avoid any situation where a customer wants to return fluid. The new reformulated products will be available within a month. We would prefer that the customer use up his current inventory and purchase Pydraul 625A, Pydraul ACA, Pydraul ACA Winter Grade and Pydraul 540A when available. He will then top off with the new fluid and eventually all Aroclor 1254 and Aroclor 1260 will be out of his system. We don't want to take fluid back. Sell him the replacement.

We must be very positive in our approach with each customer relative to our decision to eliminate the use of Aroclor 1254 and Aroclor 1260 in our Pydraul products. We (your customer and Monsanto) are not interested in using a product which may present a problem to our environment. We certainly have no reason to be defensive or apologetic about making this change. The decision to change makes good sense and our customers should commend us, not criticize our actions. No one has forced us to make this



IH-1B REV. 11 69

change. We have done it to keep our customers out of possible trouble. They should appreciate our effort, and stay with us as a customer on the reformulated Pydrauls. To make this change has cost us research monies and time. Fortunately, we possess the technical skills to make a change in our formulations without affecting the performance of products. Be positive, Take the offense. Don't let a customer or competitor intimidate you. I doubt if our competitors know whether their product could present a problem to our environment. You might ask your customer, if he has ever asked Houghton or Stauffer, Carbine, etc. about the effects of their products.

We should also recognize (point this out to your customer) we must clean-up. The Chemical Week article gives him an idea of laws in effect in his state. Read this yourself. Be familiar with the data on each state in which your customers are located. Use this in your discussions.

We have no replacement products for Aroclor 1254 and Aroclor 1260. We will continue to make these products; however, customers will have to use their own judgement on continued use.

We can't afford to lose one dollar of business. Our attitude in discussing this subject with our customer will be the deciding factor in our success or failure in retaining all our present business. Good luck.

(We have also attached a copy of the letter sent to transformer customers.)

N. T. Johnson

lb

Exhibit 14

5,000 printed
5/62

obsolete

THE aroclor COMPOUNDS

Monsanto

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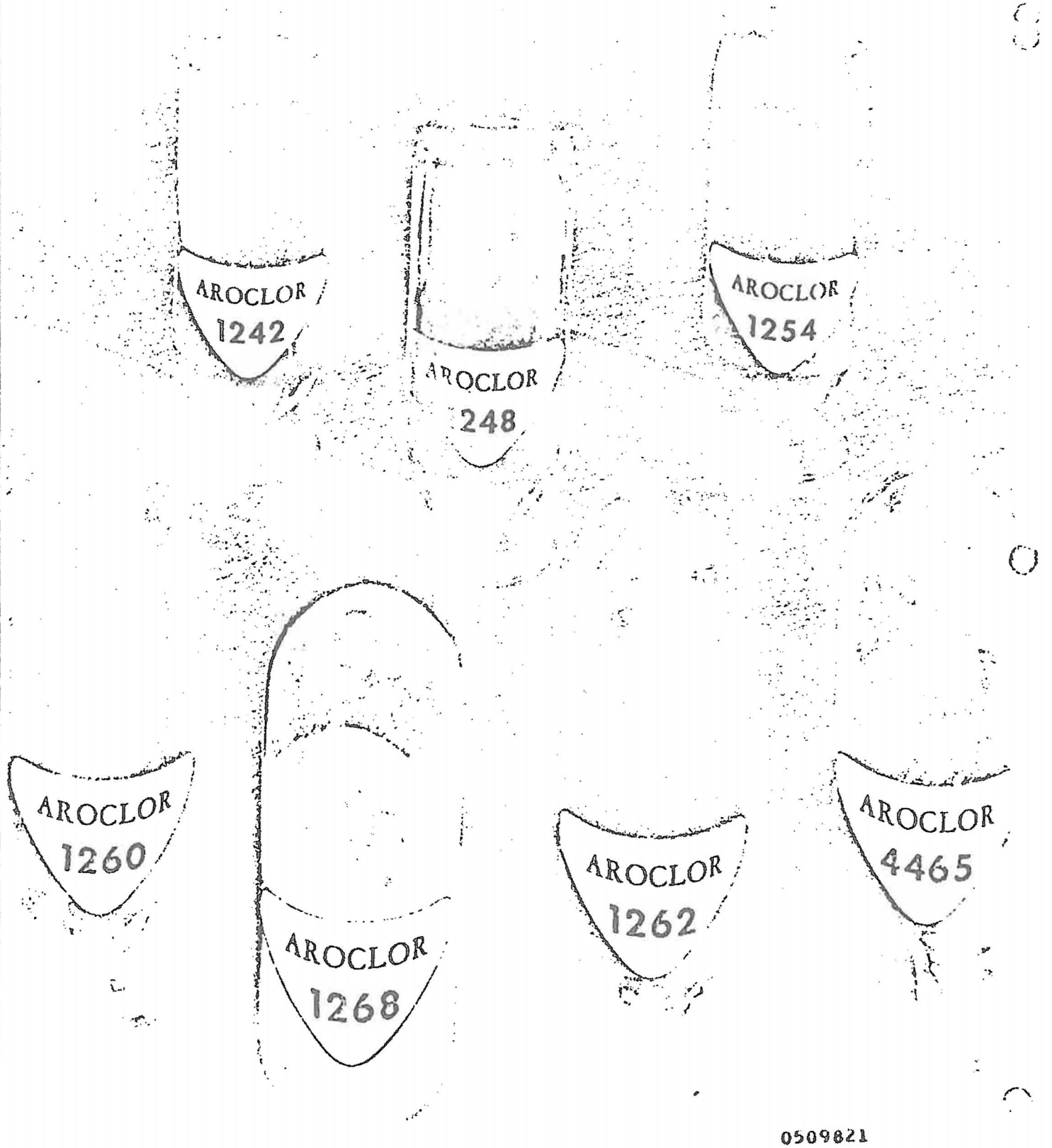
AROCLOR
1242
AROCLOR
248
AROCLOR
1254
AROCLOR
1260
AROCLOR
1268
AROCLOR
1262
AROCLOR
4465

0509821

The Aroclor* compounds are among the most unique, most versatile chemically-made materials in industry. Aroclors are so useful in so many ways in so many different applications, primarily because of one outstanding characteristic: *inertness.*

The Aroclors do not burn . . . and they impart fire-retardance to compositions in which they are mixed. The Aroclors do not "break down" under mechanical stress; therefore, they make good lubricants, sealants, and expansion media. The Aroclors are not decomposed by, nor do they conduct even tiny amounts of, electricity; therefore, they are outstanding dielectrics. Heat has little effect on the compounds, hence the Aroclors are excellent heat transfer fluids. Since they are compatible with a wide range of synthetic resins, Aroclors make excellent plasticizers. Because Aroclors in formulations "trap" and hold more volatile ingredients, they make volatile insecticides and repellents "last longer" in residual activity.

And, important too, Aroclors are low in cost. Examination of their properties will show literally scores of uses in which no other material can serve.

The following pages describe the physical properties of the Aroclors and some of their many applications. These remarkable materials are manufactured exclusively by Monsanto.

refer to technical bulletins

*Aroclor is a trademark of Monsanto Chemical Company for its chlorinated aromatic hydrocarbons and their derivatives, including chlorinated diphenyl. Reg. U. S. Pat. Ofc. In this brochure, Aroclor is frequently used as a plural noun solely to improve the ease of reading and as a convenience to the reader. In every instance of such use, however, the usage refers to Monsanto Aroclor brand of polyphenyl compounds.

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0509823

THE aroclors...

Aroclor compounds are a series of chlorinated biphenyls and chlorinated polyphenyls. They range in form and appearance from mobile oily liquids to fine white crystals and hard transparent resins. Aroclors are non-oxidizing, permanently thermoplastic, of low volatility, and non-corrosive to metals. Aroclors are not hydrolyzed by water, alkalis, or acids. The viscous liquids and resins will not support combustion when heated alone, and they impart fire retardance to other materials.

The crystalline Aroclors are relatively insoluble, but the liquid and resinous compounds are soluble in most of the common organic solvents, thinners and oils. All Aroclors are insoluble in water, glycerine or the glycols. Aroclor 5460 is insoluble in the lower molecular weight alcohols; "4465" is only partly soluble in the lower alcohols.

The following table describes the properties of twelve Aroclors, each of which is representative of a series. For almost every Aroclor shown, there is a dark-colored grade of approximately the same physical and chemical characteristics. These darker products are less pure but are lower in price.

Aroclors are used alone for particular physical jobs, such as insulating, heat transfer, sealants and expansion media; and they are used as components or extenders in elastomers, adhesives, paints, lacquers, varnishes, pigments and waxes. The properties imparted by Aroclors (and their usefulness in particular applications) vary in regular gradient over the series. Selection of the right Aroclor for a particular use can generally be made by comparision of the properties, by "blending" two or more, and by adjusting the percentage used in the particular mixture in which the Aroclors will be formulated.

0509824

general physical properties

Form	Aroclor 1221 Colorless mobile oil	Aroclor 1232 Practically colorless mobile oil	Aroclor 1242 Practically colorless mobile oil	Aroclor 1248 Colorless to light yellow-green, clear, mobile oil	Aroclor 1254 Light yellow viscous oil
Color	100 Max. (APHA)	100 Max. (APHA)	100 Max. (APHA)	100 Max. (APHA)	100 Max. (APHA)
Acidity—Maximum (Mgm. KOH per Gm.)	0.014	0.014	0.010	0.010	0.010
Average Coefficient of Expansion..cc/cc/°C	0.00071 (15°-40°C)	0.00073 (25°-100°C)	0.00068 (25°-65°C)	0.00070 (25°-65°C)	0.00066 (25°-65°C)
Typical Density Specific Gravity Pounds per Gallon—25°C (77°F)	1.182-1.192 (25°/15.5°C) 9.85	1.270-1.280 (25°/15.5°C) 10.55	1.381-1.392 (25°/15.5°C) 11.50	1.405-1.415 (65°/15.5°C) 12.04	1.495-1.505 (65°/15.5°C) 12.82
Distillation Range—ASTM D-20 (Mod.) Corr. °C	275°-320°	290°-325°	325°-366°	340°-375°	365°-390°
Evaporation Loss—%—ASTM D-6 Mod. 163°C.....5 hrs. 100°C.....6 hrs.	— 1.0 to 1.5	— 1.0 to 1.5	3.0 to 3.6 0.0 to 0.4	3.0 to 4.0 0.0 to 0.3	1.1 to 1.3 0.0 to 0.2
Flash Point—Cleveland Open Cup.....°C °F	141°-150° 286°-302°	152°-154° 305°-310°	176°-180° 348°-356°	193°-196° 379°-384°	None
Fire Point—Cleveland Open Cup.....°C °F	176° 349°	238° 460°	None* 	None	None
Pour Point—ASTM D-97.....°C °F	Crystals at 1°C Crystals at 34°F	−35.5° −32°	−19° 2°	−7° 19.4°	10° 50°
Softening Point—ASTM E-28.....°C °F	— —	— —	— —	— —	— —
Refractive Index—D-line—20°C	1.617-1.618	1.620-1.622	1.627-1.629	1.630-1.631	1.639-1.641
Viscosity—Saybolt Universal Sec. (ASTM—D-88) 210°F (98.9°C)	30-31	31-32	34-35	36-37	44-48
130°F (54.4°C)	35-37	39-41	49-56	73-80	260-340
100°F (37.8°C)	38-41	44-51	82-92	185-240	1800-2500

*NONE indicates—"No fire point up to boiling temperature"

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Some of the aroclor compounds

	Aroclor 1260 Light yellow soft sticky resin	Aroclor 1262 Light yellow sticky clear resin	Aroclor 1268 White to off-white powder	Aroclor 4465 Light-yellow, clear, brittle resin	Aroclor 5442 Yellow trans-parent sticky resin	Aroclor 5460 Clear, yellow-to-amber, brittle resin	Aroclor 2565 Black, opaque, brittle resin
	150 Max. (APHA)	150 Max. (APHA)	1.5 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	2 Max. NPA (molten)	—
	0.014	0.014	0.05	0.05	0.05	0.05	1.4
	0.00067 (20°-100°C)	0.00064 (25°-65°C)	0.00067 (20°-100°C)	0.00061 (25°-65°C)	0.00123 (25°-99°C)	0.00179 (25°-124°C)	0.00066 (25°-65°C)
	1.555-1.566 (90°/15.5°C) 13.50	1.572-1.583 (90°/15.5°C) 13.72	1.804-1.811 (25°/25°C) 15.09	1.670 (25°/25°C) 13.91	1.470 (25°/25°C) 12.24	1.670 (25°/25°C) 13.91	1.734 (25°/25°C) 14.44
	385°-420°	395°-425°	435°-450°	230°-320° at 4 mm. Hg.	215°-300° at 4 mm. Hg.	280°-335° at 5 mm. Hg.	—
	0.5 to 0.8 0.0 to 0.1	0.5 to 0.6 0.0 to 0.1	0.1 to 0.2 0.0 to 0.06	0.2 to 0.3 0.0 to 0.02	0.2 0.01	0.03 1.5 to 1.7 (at 260°—5 hr	0.2 to 0.3 —
	None	None	None	None	247° 477°	None	None
	None	None	None	None	>350° >662°	None	None
	31° 88°	35°-38° 99°	— —	— —	46° 115°	— —	— —
	— —	— —	150° to 170° (hold pt.) 302° to 338° (hold pt.)	60° to 66° 140° to 151°	46° to 52° 115° to 126°	98° to 105.5° 208° to 222°	66° to 72° 149° to 162°
	1.647-1.649	1.6501-1.6517	—	1.664-1.667	—	1.660-1.665	—
	72-78 3200-4500 —	86-100 600-850 (160°F or 71°C) —	— — —	90-150 (265°F or 130°C) — —	300 400 — —	— — —	— — —

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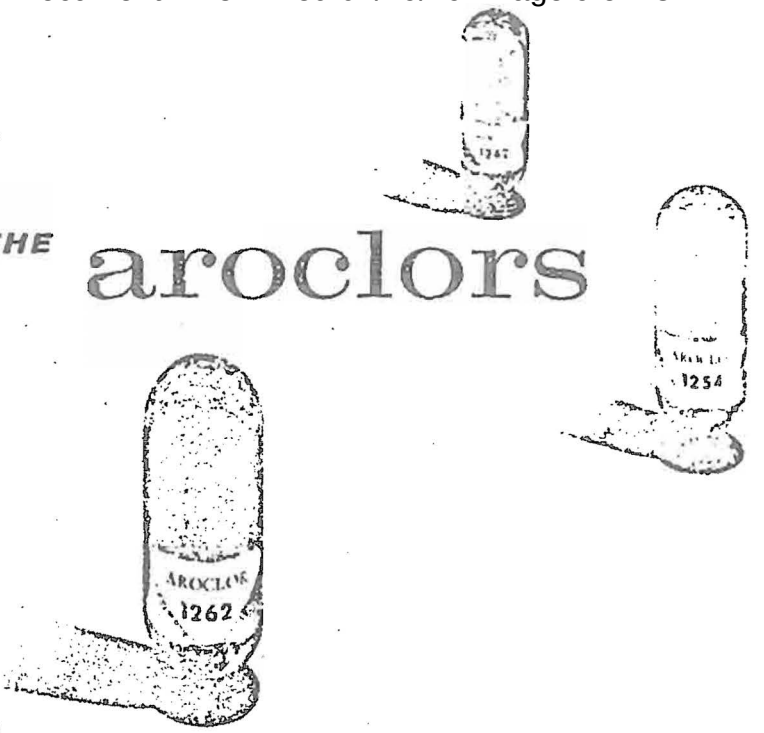
PROPERTIES THAT "MAKE JOBS" FOR THE aroclors



"NON-DRYING"

Aroclors are non-drying. Even when exposed to air in the form of thin films, no noticeable oxidation or hardening takes place. However, when used as components of paints, varnishes or lacquers, they do not retard the rate of drying of the films. Quick drying varnishes and paints can be made using Aroclors in the formulation.

"NON-FLAMMABILITY"

The viscous, oil-like Aroclors and the resins do not support combustion when heated alone, even at their boiling points — temperatures in excess of 350°C. Most of the Aroclors flux readily with other resinous and pitch-like materials to make mixtures that gain in fire retardance properties. Even when incorporated in nitro-cellulose films and rubber foams, Aroclors will retard the rate of burning.

"ADHESIVENESS" AND "THERMOPLASTICITY"

The Aroclor resins adhere strongly to smooth surfaces such as glass, metal, varnished or lacquered coatings.

The Aroclors are permanently thermoplastic. They apparently undergo no condensation or hardening upon repeated melting and cooling. Clear Aroclor resins can be supplied with softening points up to 105°C. Opaque, crystalline Aroclors can be supplied with initial melting points up to approximately 290°F.

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STABILITY

Toward Alkalies — The Aroclors are remarkably resistant to the action of either hydrolyzing agents or high temperature. They are not affected by boiling with sodium hydroxide solution.

Toward Acids — Experiments were made to determine whether hydrogen chloride is evolved during the treatment of Aroclors with sulfuric acid. Aroclor 1254 (selected as typical) was stirred with an equal volume of ten per cent sulfuric acid for a period of 150 hours. Any gases escaping from the reaction flask had to pass through a trap filled with silver nitrate solution, which solution would give a precipitate of silver chloride if any HCl came in contact with it. After 150 hours of treatment, neither the trap solution nor the acid layer in the treating flask showed any hydrogen chloride present.

Even prolonged treatment (255 hours) with concentrated sulfuric acid indicated negligible effect.

Toward Heat — Because of their stability to heat, the Aroclors are useful heat transfer media. Aroclor 1254 and particularly the less viscous Aroclor 1248 are recommended for this purpose because they may be heated at temperatures up to 315°C (600°F) in a closed system for long periods without appreciable decomposition and they are, at the same time, fire resistant.

Toward Oxidation — When Aroclors are subject to a bomb test at 140°C with 250 pounds oxygen per square inch, there is no evidence of oxidation as judged by development of acidity or formation of sludge.

ELECTRICAL RESISTIVITY

The Aroclors have extremely interesting electrical characteristics: high resistivity and dielectric strength and low power factor. The dielectric constant ranges from 3.4 to 5.0 at 100°C and 1000 cycles, depending upon the particular Aroclor.

SOLUBILITY

All Aroclors are insoluble in water. They are soluble, however, in most of the common solvents, plasticizers, and resins.

The Aroclor oils and resins are readily soluble in most of the common organic solvents and drying oils. The hard crystalline Aroclors are in general less soluble than the liquids or softer Aroclor resins. All the Aroclors are heavier than water, a valuable property for many applications.

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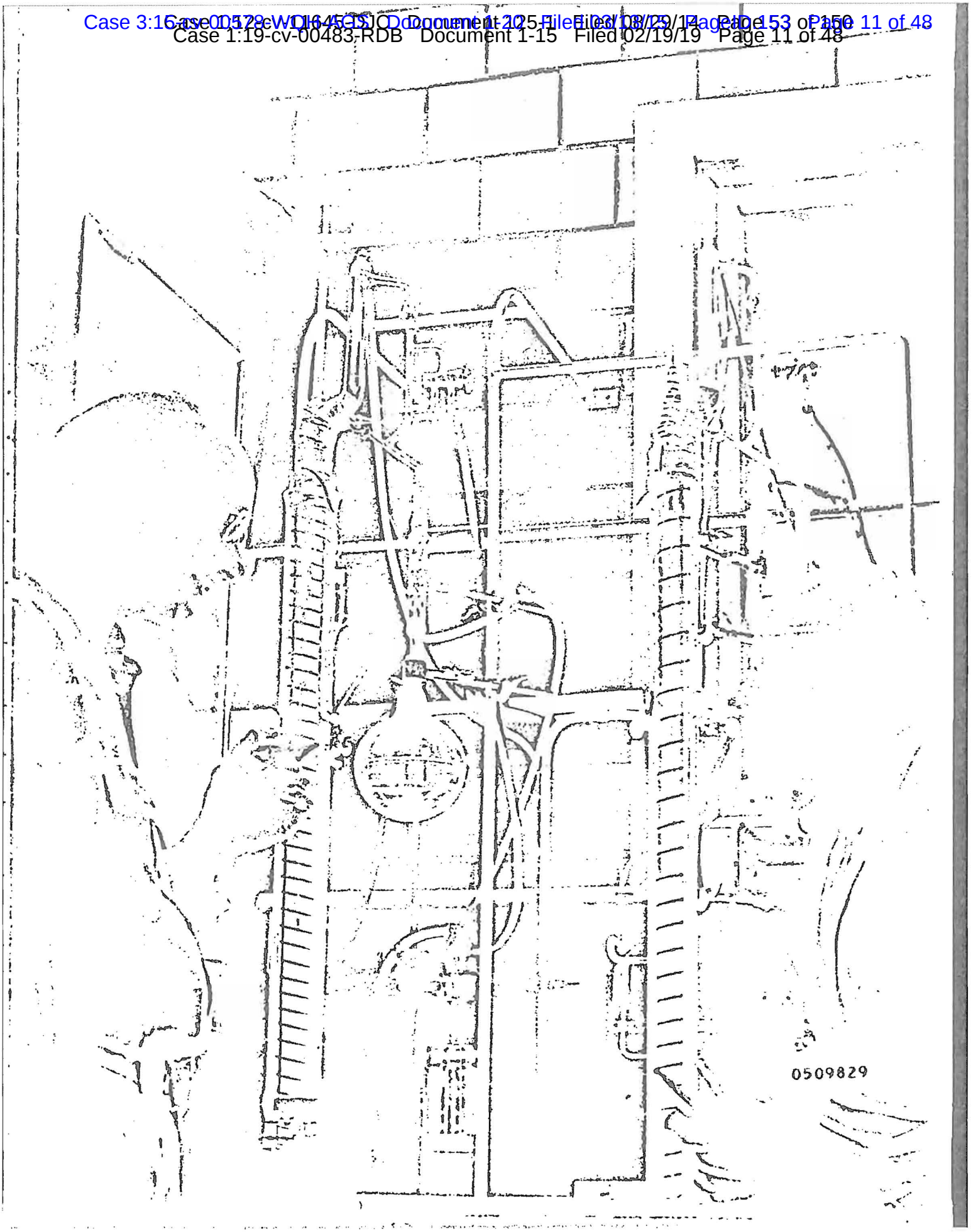
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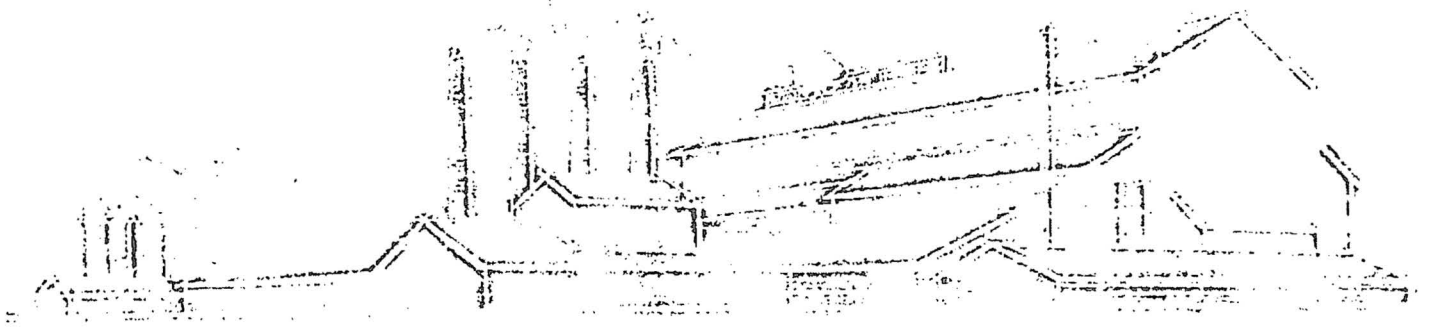
industrial applications of the aroclors



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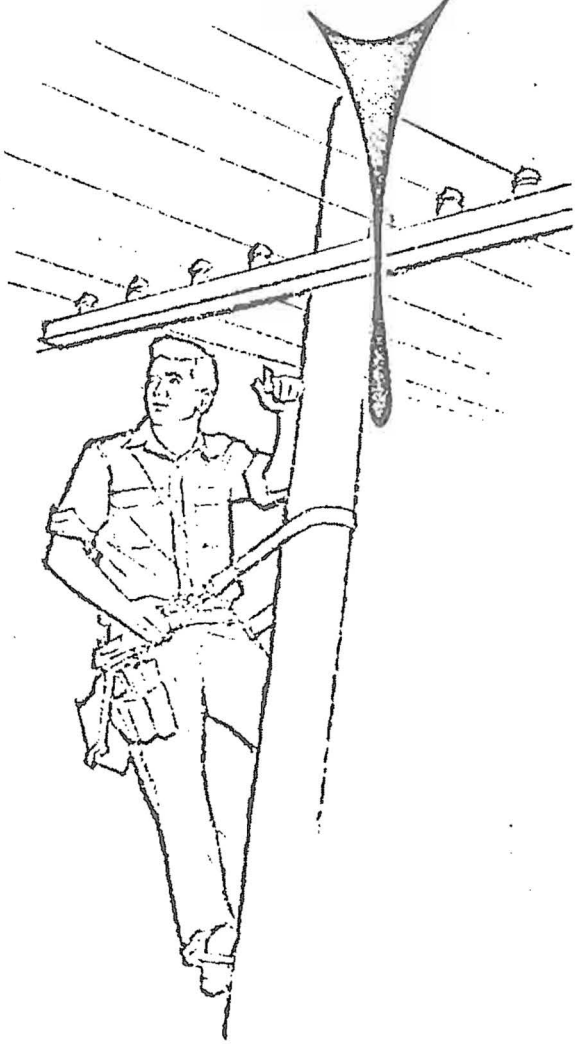
Aroclors are among the purest commercial chemical compounds, virtually free of even traces of conducting impurities. For this reason, the Aroclors' dielectric properties closely approximate the theoretical maximum for the particular organic compound. With their stability, heat resistance and flame resistance — Aroclors can be used for a variety of heavy-duty dielectric applications.

electrical applications of aroclors



DIELECTRICS FOR ASKAREL TYPE TRANSFORMERS AND CAPACITORS

Monsanto Aroclors are used *per se* and are formulated for the liquid coolant-insulation fluids in transformers and capacitors. Such dielectrics must be highly pure with dependably minimal traces of electrolytes. They must be chemically stable and non-corrosive to a wide variety of structural materials. Most important, the dielectric fluid must be fire-resistant.

Aroclors are the only liquids in low cost commercial supply that meet these exacting requirements.

Liquid Aroclors "1242," "1248," "1254," and "1260" are used directly, or these are carefully formulated with chlorinated benzene and other additives to make askarel fluid for particular needs. Typical formulated askarel fluids are shown on the following pages.

Aroclors "1242" and "1254" themselves or in special formulations are used as the dielectric in fixed paper capacitors, for the power factor correction in utility transmission lines; for home appliances such as air conditioners, furnaces, washers and driers; for electric motors; and for ballast in fluo-

0509831

rescent fixtures. There are also a number of applications in DC systems, in condensers, and the new energy storage capacitors.

The Aroclor fluids can be used in a wide variety of applications requiring a specialized dielectric. Monsanto works closely with electrical equipment makers to develop the proper dielectric with the exact physical properties required by the engineering of the equipment.

IMPREGNATING COMPOUNDS

Because of their nonflammability, high resistivity, and dielectric strength and low power factor, the liquid and resinous Aroclors are extremely useful materials for many applications as impregnating compounds. An important application of Aroclors in the electrical field is the use of Aroclors 1260, 4465 and 5460 in wire or cable coatings and as impregnants for cotton and asbestos braided insulation. Because they possess high purity and excellent electrical resistance, Aroclor 1254, 5460 and 1268 make excellent dielectric sealants: to close the pores of carbon resistors, and to seal electrical bushings and terminals.

Since the liquid Aroclors will absorb sufficient moisture from the atmosphere to impair the electrical characteristics, it is customary to treat Aroclor intended for this application before use with a dehydrating clay. An effective product for this purpose is Attapulgus clay 80/300 mesh dried for 4 hours at 400°C. and used at the rate of 0.10% based on the weight of Aroclor, followed by filtration. Treatment is improved if the Aroclor is heated to 50-55°C.

ELECTRICAL PROPERTIES

Aroclor	Dielectric Constant at 1,000 Cycles (1) 25°C	100°C	Volume Resistivity (2) Ohm-cm at 100°C, 500 Volts D.C.	Dielectric Strength (3)	Power Factor (4) 100°C, 1,000 Cycles
1232	5.7	4.6			
1242	5.8	4.9	Above 500×10^7	Greater than 35KV	<0.1%
1248	5.6	4.6	Above 500×10^9	Greater than 35KV	<0.1%
1254	5.0	4.3	Above 500×10^9	Greater than 35KV	<0.1%
1260	4.3	3.7	Above 500×10^7	Greater than 35KV	<0.1%
1268	2.5	—			
5442	3.0	4.9	Above 500×10^9		
5454	2.7	4.2			
5460	2.5	3.7			
4465	2.7	3.3			

(1) ASTM D-150-47T
(2) ASTM D-257-46
(3) ASTM D-149-44
(4) ASTM D-150-47T

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TYPICAL TRANSFORMER ASKAREL

(MIXTURE OF AROCLOR AND CHLOROBENZENES)

Property	*Typical*
Visc. @ 37.8°C. (ASTM D88)	41-45 Sec. Saybolt Univ.
Spec. Gravity @ 15.5/15.5°C., (ASTM D287)	1.563-1.571
Color, APHA	150 max.
Condition	Clear
Acidity, mg. KOH/g.	0.01 max.
Pour Pt., °C., (ASTM D97)	−44°C., or lower
Inorganic Chlorides, ppm	0.10 max.
Refractive Index @ 25°C.	1.6075-1.6085
Distillation Range (ASTM D20) Corrected for stem and barometric pressure	
First drop	210°C. min.
35%	240-256°C.
55%	290-330°C.
65%	385-400°C.
95%	395-415°C.
Corrosion	After heating with aluminum for 6 hrs. @ 200-220°C., the aluminum must not be corroded either on visual or weight inspection.
	The askarel fluid meets the following specifications:
Color, APHA	200 max.
Acidity, mg. KOH/g.	0.01 max.
Inorg. Chlorides, ppm	5 max.
Condition	Clear
Water Content, ppm.	30 max.
Resistivity, 100°C., 500v., 0.1" gap	100 x 10⁹ ohm-cm., min.
Dielectric Strength, 25°C.	35 KV., min.
Dielectric Constant, 100°C., 1000 cycles*	3.8-4.2
Tin Tetraphenyl*	0.125% ± 0.01% by weight
Burn Point, (ASTM D92)*	None up to Boiling Point
Fixed Chlorine*	60.5 ± 0.5
Arc Formed Gases* (Oxygen Free Liquid @ 25°C.)	Total combustible gases including carbon monoxide, hydrogen and volatile hydrocarbons.
Electrical Stability*	After heating for 96 hours @ 100°C in a closed container, the resistivity should not decrease more than 10%.

TYPICAL CAPACITOR AROCLOR

Property	*Typical*
Visc. @ 37.8°C. (ASTM D88)	82-92 seconds Saybolt Univ.
Specific Gravity @ 25/15.5°C (ASTM D287)	1.381-1.392
Color, APHA	50 max.
Condition	Clear
Acidity, mg. KOH/g.	0.01 max.

*Determined by special request.

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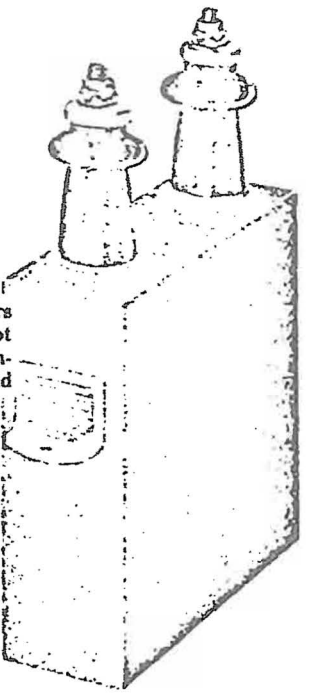
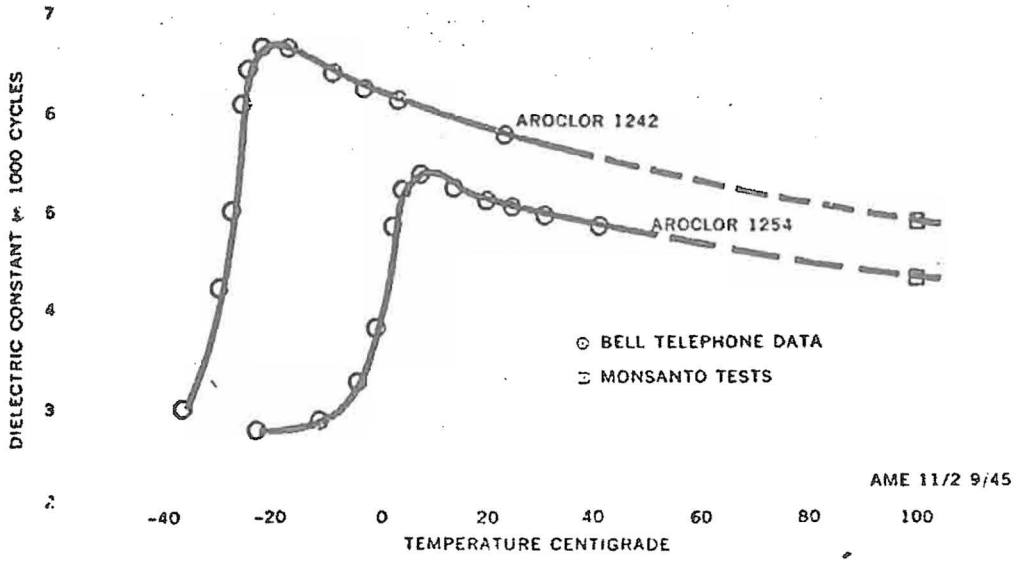
Typical Capacitor Aroclor (continued)

Property	Typical
Pour Pt., °C. (ASTM D97)	−14 or lower
Inorganic Chlorides, ppm.	0.10 max.
Refractive Index @ 25°C.	1.6240-1.6260
Distillation Range (ASTM D20) Corrected for stem and barometric pressure	10% 325°C. min. 90% 360°C. max.
Corrosion	After heating with aluminum for six hours at 210°C ± 10°C the aluminum must not be corroded either on visual or weight inspection and the Aroclor 1242 should meet the following specs.: Color, APHA 60 max. Acidity, mg. KOH/g. 0.01 max. Inorg. Chlorides, ppm 0.10 max. Condition Clear
Water Content, ppm	35 max.
Resistivity 100°C. 500 volts DC @ 0.1" gap	500 x 10^9 ohm-cm., min.
Dielectric Constant 100°C. @ 1000 cycles (ASTM D924)	4.7-4.9
Flash Point Cleve. Open Cup*	170°C., min.
Fire Point °C.*	None to boiling point
Sulfates (ASTM-D117-31)*	None
Fixed chlorine content (Carius)*	41.5-42.5%
Specific Heat @ 25°C.*	0.29
Evaporation @ 100°C for 6 hrs.*	0.4% max.
Dielectric Strength (KV) (ASTM D877)*	35 Min.

*Determined by special request.



DIELECTRIC CONSTANT VS. TEMPERATURE
AROCLOR 1242 & AROCLOR 1254



BY COURTESY OF THE JOURNAL OF FRANKLIN INSTITUTE AND BELL TELEPHONE LABORATORIES

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11

Because Aroclors have excellent shear resistance, heat stability, and are chemically stable . . . they can serve in dozens of mechanical applications for transferring mechanical power, heat, and variable pressures. Aroclors do not attack metals even at high temperature; they resist oxidation, chemical and mechanical breakdown under a wide variety of environmental conditions. In addition, the Aroclor liquids used as lubricants impart a high degree of extreme pressure lubricity.

mechanical applications of aroclors

HEAT TRANSFER

Aroclors are outstanding for use as the heat transfer liquids in indirect heating systems. Aroclor systems can transfer closely controllable, uniform heat to chemical processing vessels, food cookers, potato chip fryers, drying ovens and other installations where the fire source must be removed from the point where the processing heat is used. Aroclor 1248 is used most frequently in such indirect heating systems.

Heat transfer with Aroclors has many advantages. Processing heat up to 600°F. can be delivered in a *non-pressurized* system, reducing the construction costs of the heating system. The fluid in properly engineered systems will last without significant degradation for from five to seven years. The systems present no fire or explosion hazard, since the Aroclor does not support combustion. In addition, there is no day to day conditioning of boiler water, inasmuch as the Aroclor requires no conditioning, and Aroclor systems require a minimum amount of insulation. Aroclor systems operating at atmospheric pressure have been used successfully since 1941. Aroclor systems can operate safely and efficiently on gas, oil or electricity.

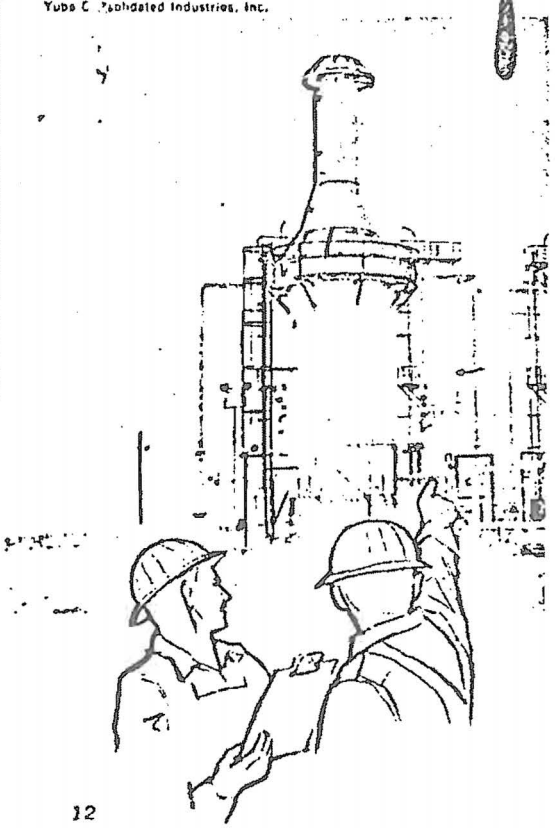

Photo courtesy of
Petro-Chem Development Division
Yuba C[illegible]dated Industries, Inc.

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Aroclors 1242, 1248 and 1254 are used as a circulating heat transfer medium with great success. Good circulation and a well designed heating system are necessary to prevent local overheating. Aroclor 1248, however, is recommended for universal use up to 315°C (600°F) because of its fluidity at low temperatures and its fire-resistance. The liquid Aroclor 1248 is readily pumpable with centrifugal pumps to temperatures as low as 50°F.

In processes where a cooling cycle must also be introduced, provision can easily be made for shunting circulating Aroclor through a water cooled heat exchanger, thus employing one medium for both heating and cooling.

In special cases, Aroclors 1242 and 1232 can be substituted for the Aroclor 1248. If low outside temperatures are encountered, the less viscous Aroclor 1242 can be used.

Aroclor 1232 may be used where outdoor temperatures as low as 20°F are encountered. While Aroclor 1232 is serviceable for unpressurized heat transfer, this Aroclor compound is not quite as fire resistant as "1248" or "1242."

Monsanto has available an "Engineering Heat Transfer Data" booklet that gives design guidance on Aroclor systems. In addition, Monsanto can suggest sources for Aroclor heaters and equipment.

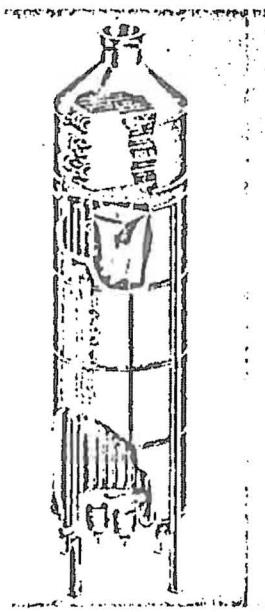

Photo courtesy of Western Precipitation Corp.

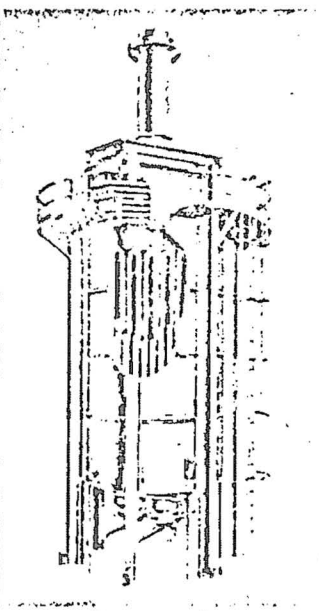

Photo courtesy of Struthers Wells Corp.

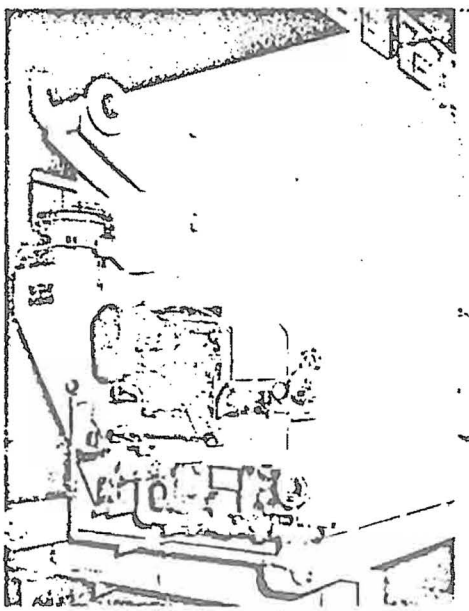

Photo courtesy of Union Iron Works

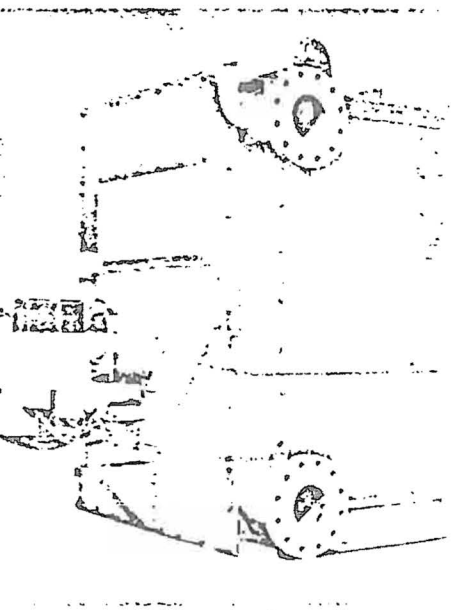

Photo courtesy of The International Boiler Works Co.

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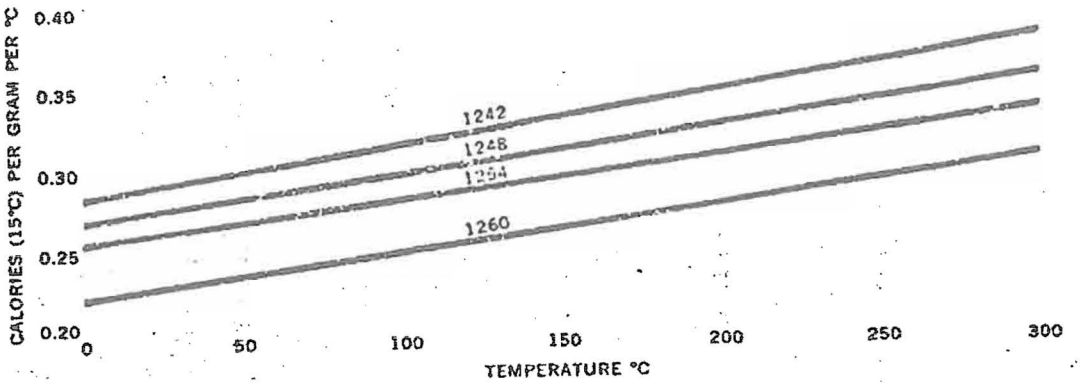
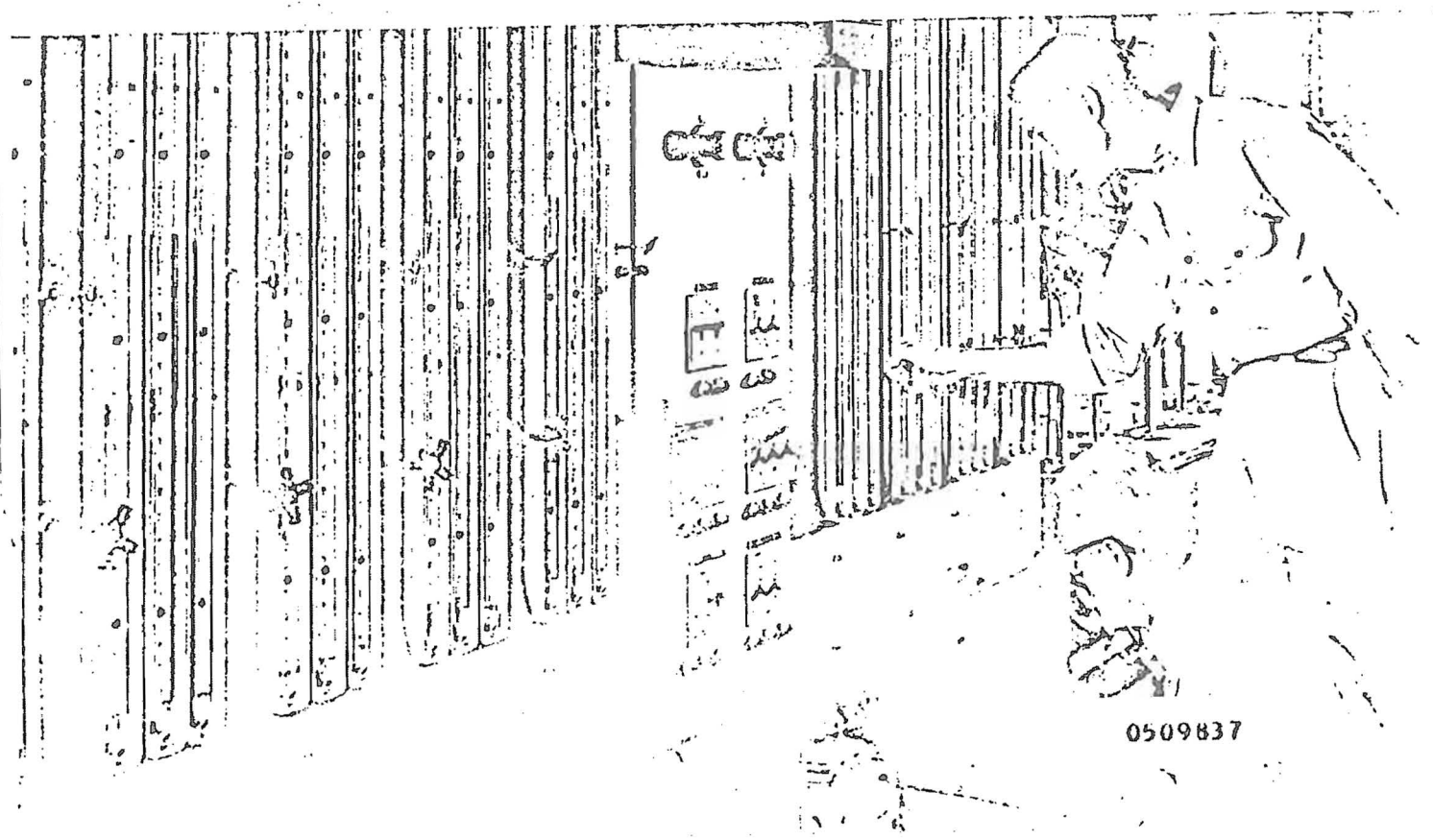
HEAT CAPACITY OF AROCLORS
AT VARIOUS TEMPERATURES



THERMAL CONDUCTIVITY OF AROCLOR 1248

Temperature °C.	Temperature °F.	BTU./Hr./Sq. Ft./°F./Ft.	Calories, gram/Sec./Sq.Cm./°C./Cm.
30	86	0.0570	236×10^{-6}
60	140	0.0564	233×10^{-6}
100	212	0.0555	229×10^{-6}



EXPANSION MEDIUM

Because of their stability at high temperatures and ability to withstand frequent temperature cycles without gum formation, the liquid Aroclors are used as the actuating medium in bellows controls, thermostats, industrial temperature control regulators and other kinds of automation equipment.

The average coefficient of expansion of Aroclor 1248 per degree F. within the various temperature ranges indicated in the table below was determined by using the simple formula $Vt = Vt' [1 + a (t - t_1)]$. The coefficient, a, has been calculated at 100°F increments, as follows:

Temp. Range F	Average Coefficient of Expansion cc/cc/F
0 to 100	0.00037
100 to 200	0.00039
200 to 300	0.00040
300 to 400	0.00046
400 to 500	0.00048
500 to 600	0.00051

The specific volume of Aroclor 1248 at different temperatures is as follows:

Temp. °F.	Specific Volume ml/gm
0	0.674
100	0.699
200	0.726
300	0.755
400	0.790
500	0.828
600	0.870

LIQUID SEALANT FOR FURNACE ROOFS

The liquid Aroclors 1248 and 1254, because of their low vapor pressures and fire-resistance, make excellent liquid sealants. These non-evaporating fluids have good flow at slightly elevated temperatures and are chemically stable at elevated temperatures. Consequently, the liquid Aroclors make excellent fluid sealants for any application where the use of oil would create a fire hazard. In the trough of annealing furnaces, for example, Aroclors make dependable fire-safe roof seals.

VACUUM DIFFUSION PUMP OIL

The fluid Aroclors 1248 and 1254 are highly stable to air; they make good oils for vacuum pumps at a much lower cost than high priced silicone type oils. These Aroclors operate efficiently in vacuum diffusion pumps used to pull high vacuum for metalizing plastics; dehydrating foods, medicinals; and for drying capacitor cones.

DUST ENTRAPMENT

Because Aroclors are non-drying and tacky, they make excellent coatings for capturing dust, lint and other fine air-borne particles. Aroclors 1260 and 5460 are used successfully to coat fibrous glass air filter pads, metal mesh and other materials used for filtering air and gas streams.

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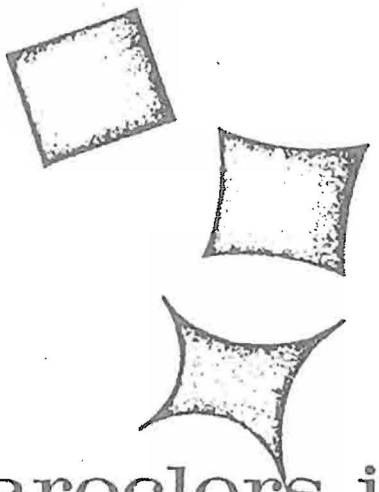
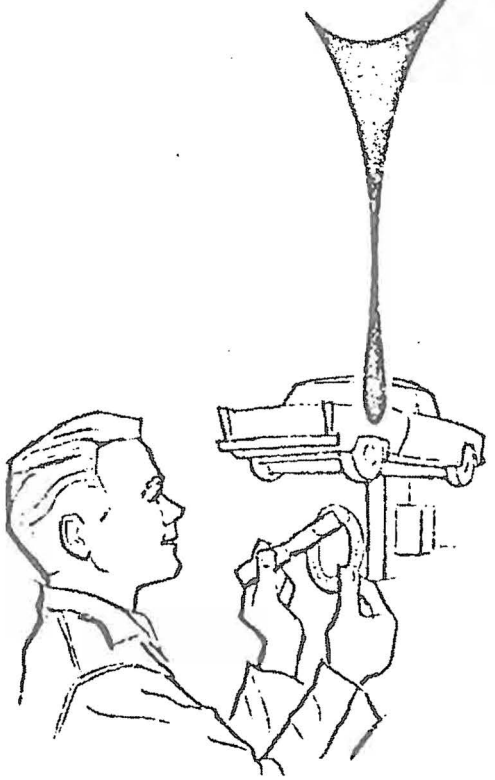


With their wide range of physical properties, their inertness, lubricity, and vapor-suppressing characteristics — Aroclors can be valuable ingredients in an extraordinary variety of formulated products. They are compatible with a variety of solvents, oils, resins. They are virtually non-volatile and permanently thermoplastic; they will not react with other chemicals in the formulation. In addition, their low cost makes their use for special purposes eminently practical and economical.

aroclors in special product formulations



SEALERS FOR GASKETS

Aroclors — particularly when hot — swell rubbers like Hycar, Koroseal, PerBuna N, and Neoprene. Wherever seals and gaskets of natural or synthetic rubber tend to shrink under heat and use, Aroclors 1232, 1242 or 1254 can be used as a swelling agent to tighten the shrunken seal. An example is in automotive transmission oil: a small amount of Aroclor in the oil swells the seal *in place*, saving the cost of tearing down the equipment to replace the seal or gasket. Aroclors can be used in gasket sealing compounds to swell the rubber after the gasket or seal is in place.

DEDUSTING AGENT

Aroclor 1254 is a low cost dedusting agent which can "hold down" the dusting of a variety of chemical products. Because Aroclor 1254 resists both combustion and oxidation, it can be used to control dusting of highly reactive compounds. As a typical example,* a few tenths of one percent will control the dusting of calcium hypochlorite.

*Covered by U. S. Patent No. 2,921,911, issued January 19, 1960, and assigned to Pennsalt Chemicals Corp.

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Aroclor 5460 and 1254 act as vapor suppressants. The United States Department of Agriculture scientists reported that the inclusion of from 5 to 25 parts per hundred by weight of Aroclor increased the effective kill-life of a lindane spray up to ten times. A painted or metallic surface sprayed with certain chlorinated insecticides fortified with Aroclor will remain toxic to flies, ants, roaches, silverfish up to 2 to 3 months. The Aroclor resins suppress the rapid evaporation of the volatile insecticides without adding odor or other objectionable residue. Formulation into insecticides is quite simple; the Aroclor is dissolved in a suitable solvent compatible with the insecticide formulation, and mixed in. The most pronounced effect for increasing the kill-life of the insecticide is obtained with lindane, chlordane and BHC. Aroclors are recommended for chlorinated insecticide formulations to be used for non-crop spraying. Their low cost makes this use a most practical way to lower the ultimate cost of insect control.

Aroclors are compatible with various natural waxes, such as carnauba and others, including those used to formulate casting wax. Aroclors help impart to the finished casting wax a number of desirable properties: hardness without brittleness; resistance to shrinking; sharp definition; sharp melting point; and fire-resistance. Waxes formulated with Aroclors are non-tacky and highly stable. Aroclor-containing waxes are widely used in making dental castings, in the precision casting of aircraft parts, and for casting costume jewelry. Aroclors 1254, 4465 and 5460 are the ones most frequently used, the proportions dependent upon the properties required in the finished wax. Much of the highest quality precision casting wax used in the "lost wax" process is formulated with Aroclors.

Aroclors 1254, 1268 and 5460 are used in the manufacture of specialized abrasives. Because of their excellent bonding characteristics, high thermal stability and resistance to oxidation and corrosion — Aroclors are used as the carriers for abrasive materials. A major use is as part of the bonding agent in specialized grinding wheels.

For specialized lubricants requiring good extreme pressure (EP) characteristics, the liquid Aroclors make excellent additives. The Aroclors impart high temperature stability, excellent lubricating qualities, and weather and corrosion resistance. As an example, Aroclors are used to formulate grease and pipe thread compounds for use in oxygen systems. Greases formulated with Aroclors have a high chemical resistance, are suitable for use in contact with corrosive chemicals. Gear oil lubricants containing Aroclors have good resistance to sheer degradation and high

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temperature stability. Added in small amounts to railroad car journal box oils, Aroclors impart better extreme pressure lubricity and reduce the incidence of "hot boxes."

The heat-resisting, nonflammable characteristics of the Aroclors make them attractive in themselves as lubricants under conditions of high temperature. As an example: in governor systems of central power stations, Aroclor 1248 is well suited to this lubricating application.

Straight Aroclor 1254 gives excellent results on a roller bearing test operating at 255-260°F with much less carbonization or decomposition than the usual spindle oil under the same conditions.

As an extreme pressure (EP) lubricant base added to a petroleum hydrocarbon oil in amounts up to approximately 15% by weight, Aroclors 1248 and 1254 materially increase the load-carrying properties without reducing the viscosity of the resulting composition. These two Aroclors represent one of the more satisfactory carriers for the element chlorine as an extreme pressure base, possessing the following advantages:

1. **STABILITY** . . . even at higher temperatures, which assures there will be neither separation of components nor appreciable change in physical or chemical properties during long periods of operation.
2. **NON-VOLATILE.** Many other types of chlorine bearing compounds are so volatile as to render them unfit for long periods of service. The Aroclors are non-volatile at normal temperatures.
3. **NON-OXIDIZING.** Aroclors do not oxidize nor "thicken up" to an objectionable degree.
4. **NON-CORROSIVE** . . . toward metal surfaces.
5. **NON-ABRASIVE.** Aroclors exerts no abrasion on the machined surfaces.
6. **NON-HYDROLYSIS.** Aroclors do not hydrolyze in the presence of water, thus avoiding the generation of hydrochloric acid.
7. **COMPATIBILITY.** Aroclors are completely miscible with mineral oils.
8. **COLOR.** Aroclors do not darken or change the color of lubricating oil.

Submerged Lubrication

Under conditions of lubrication subjected to exposure to water displacement such, for example, as lubrication of bridge rollers, a heavier-than-water lubricant can be prepared from mixtures of Aroclor and oil, of which the following are typical examples:

Mix No.	% by weight Oil*	Aroclor 1248	Pour Pt.	Gravity at 15.5°C.	Approx. Pounds Gal.
1	50	50	0°F	1.1263	9.4
2	25	75	+5°F	1.2703	10.6

Viscosity 210°F-160 Saybolt Secs.
Color ASTM 7-8
Flash Point 545°F.
Pour Point 15°F.

*Bright Stock: Gravity API 22-23

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Aroclors in Industrial Cutting Oils

Aroclor 1254 is used to formulate the finest quality "straight" and "soluble" or emulsifiable-type cutting oils. The Aroclor functions as an excellent extreme-pressure lubricant and it is far superior to aliphatic chlorinated hydrocarbons because of its higher order of thermal stability. The heat resistance is most important in cutting oils for machining high grade steel. With Aroclor cutting oils there is a lower degree of hydrolysis which minimizes the staining of the metal.

AROCLORS IN ADHESIVES

Aroclors are outstandingly useful ingredients in the formulation of various types of adhesives. Besides a plasticizing action on the adhesive's resin base, they add valuable properties to the adhesive bond. Aroclors offer a variety of property improvements to adhesives based on polyvinyl acetate, to rubber cements and to hot melt adhesives.

Aroclors strongly resist attack by water, acids, alkalies and other common corrosive influences, as well as microorganism attack. By proper selection of materials, adhesives containing Aroclors can have outstanding resistance to most of the destructive factors that injure bonding properties.

Hot-Melt Adhesives

A typical starting formulation for a cellulose acetate butyrate hot melt adhesive with Aroclor 5460 is:

	Parts by Weight
Half-second cellulose acetate butyrate	35.00
Aroclor 5460	30.00
Dioctyl phthalate	15.00
Newport V-40	19.89
Santonox*	0.1
Syn Fleur #6	0.01

The above coating can be applied at about 350°F. Ventilation should be provided.

A typical starting formulation for an ethyl cellulose hot melt adhesive with Aroclor 5460 is:

	Parts by weight
Ethyl cellulose, 50 cpr	24
Aroclor 5460	7
Lopor No. 45 Mineral Oil	57
Bakers No. 15 Castor Oil	5
Epoxy soybean oil	3
Paraffin wax (m. p. 135°F)	3
Santonox*	1

*Santonox: Monsanto Chem. Co. trademark. Registered U. S. Pat. Ofc.

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Heat Sealing Adhesives

Chlorinated rubber and Aroclors 1254 and 1260 make excellent heat sealing and label adhesives. These adhesives have high chemical resistance and extremely low moisture vapor transmission. A typical starting formulation is:

	Parts by weight
Parlon (125 centipoise type)	20
Aroclor 1254	6
Aroclor 5460	6
Toluene	68

PVAc Emulsion Adhesives

Aroclors 1221, 1232, and 1242 impart excellent tack and strong bonding power to polyvinyl acetate emulsion adhesives. They readily blend with simple stirring and since they are liquid at room temperature no pre-melting is required. The hardness required in the adhesive's end use can be varied to suit simply by selection of the Aroclor without materially changing other properties. The Aroclors are compatible with PVAc emulsions at a level of up to 11 parts of Aroclor in 100 parts of PVAc emulsion.

An excellent type of hot melt book binding adhesive can be made as follows:

	Parts by weight		
	Formula 17	Formula 18	Formula 19
Gelva polyvinyl acetate resin V-7	100	65	—
Ethyl cellulose	—	15	—
Gelva C-SV-16R	—	—	100
Santicizer 160	—	16	—
Rosin WW	75	—	75
Dibutyl phthalate	30	—	30
Aroclor 1254	55	4	55

By changing the type of polyvinyl acetate resin utilized in the hot melt, the viscosity of the melt can be increased or decreased without changing the ratio of resin to plasticizer.

Polyurethane Resin Adhesives

An excellent flocking adhesive containing Aroclor 1254 can be made as follows:

		Parts by weight
Part A —	Multranil FLD*	100
	Aroclor 1254	20
	Mondur *C	5
Part B —	Multranil FLD*	100
	Mondur C*	5-10

Part A is applied to the fabric by knife coating and allowed to dry thoroughly. The fabric is then coated with Part B, and the material is flocked immediately.

*Mobay Chemical Co. trademark, Registered U. S. Pat. Off.

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Epoxy Adhesives

Aroclors can be used to extend epoxy resin adhesives. The extending greatly reduces the formulation cost with a minimum effect on the bonding characteristics of the adhesive.

Aroclors can be used to extend or substitute Carnauba Wax and reduce the cost of the wax formulation. Several practical formulas are available using Aroclors to make wax blends that possess the qualities of Carnauba Wax. These blends can be used for automobile, wood, leather and linoleum polishes.

Selected Aroclors such as 5460 used in conjunction with various waxes make excellent impregnating compounds for furniture drawers, etc., to prevent sticking.

Resinous Aroclors used in combination with waxes make excellent and inexpensive sealers for concrete and masonry surfaces, wood, fiber board and paper products.

The Aroclors may be used to impregnate cloth, paper, wood or asbestos in order to impart moisture and gas resistance, adhesion, insulating properties, alkali or other chemical resistance, flame resistance, or lubricating qualities. For this type of formulation they are used in combinations with other materials such as waxes, inorganic pigments, asphalt, tars, aluminum stearate, sulphur, etc., in order to obtain exactly the physical characteristics desired for the specific purpose. Aroclors 1254, 4465 and 5460, or the corresponding dark-colored products, are suggested as most applicable.

Wood impregnated by vacuum-pressure method with the following mixture:

Aroclor 4465	70%
Microcrystalline Wax	20%
Sulfur	10%

. . . is definitely tougher, harder and more moisture resistant than untreated wood. This coating is very resistant to acids and alkalies but will be attacked by aromatic, aliphatic or chlorinated hydrocarbons. The surface is not appreciably discolored and can be painted. Various degrees of hardness and adhesion can be obtained by varying the Aroclor: wax: sulfur ratio.

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For use as moisture-proof coatings on wood, paper, concrete and brick, the Aroclors are best combined with waxes, especially paraffin or Carnauba, oils such as mineral oil or drying oils, and synthetic resins including modified alkyds, phenolics, chlorinated rubber, polystyrene, styrene-butadiene co-polymers, ethyl cellulose, cellulose acetobutyrate, benzyl cellulose or vinyl resins. Selection of materials for use in combination with Aroclors depends on end use requirements of the specific application.

The simplest compositions contain only Aroclor and paraffin. A moisture proofing compound composed of 96% (by weight) of Aroclor 5460 and 4% paraffin (melting point 54°C) has an ASTM softening point of about 82°C and is very efficient. Substituting Aroclor 4465 for Aroclor 5460 produces a compound with a softening point of about 58°C.

Softening point and viscosity when melted may be further decreased by using mixtures of Aroclors. For example, a composition containing 40% of Aroclor 1260, 56% of Aroclor 5460 and 4% of paraffin will be very soft at ordinary temperatures. Increased proportions of paraffin will also produce softer compounds.

An excellent melt coating for paper and cloth was reported by W. M. Gearheart and F. M. Ball, OFFICIAL DIGEST, Vol. 343, 1953:

Half-second Butyrate	50%
Dioctyl phthalate	9.9%
Aroclor 1260	40%
Ionol	0.1%

This coating may be applied by knife or roller at 350°F; the applicatio. requires no solvent. This coating on paper or fabric has extremely good flexibility.

Aroclor 4465 is a useful resin for compounding rotogravure and other printing inks. A mimeograph ink suitable for use on bond paper contains the following ingredients:

Aroclor 4465	40%
Lubricating Oil (SUV 1200 @ 100°F)	35%
Paraffin Oil (SUV 76 @ 100°F)	20%
Carbon Black	4%
Oil Soluble Dye	1%

Aroclor 4465 may also be used in the preparation of imitation gold leaf. A thin coating of the Aroclor is applied hot to one side of paper. While it is still hot, bronze powder is spread upon the coating. The bronze powder adheres to the Aroclor completely covering the paper. This product is used in making the "gold

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leaf" letters on books, etc. The paper treated with Aroclor and bronze powder is placed upon the book binding. A hot die is pressed upon it. The Aroclor softens and sticks the bronze to the binding and forms a coating over it to protect it from tarnishing.

The Aroclors are also used as vehicles for carrying the pigments used in glass decoration. When the decorations have been applied and the glass is fired, the Aroclors volatilize without carbonization and thus avoid discoloration of the glass. Aroclors 1254 and 4465 are used for ceramic decoration.

PAPER TRANSPARENTIZER

A treating liquid that makes paper transparent for use as tracing paper, window envelopes, and special packaging can be formulated with Aroclor 5460 and polybutenes. A typical economical formulation is:

Aroclor 5460	30%
Indopol H-300	25%
Toluene	45%

In the paper treating formula, the proportions of Aroclor to Indopol may be varied from 2:1 to 1:2 respectively.

MASTICS, SEALING AND CAULKING COMPOUNDS

Aroclors and polybutenes can be blended with inorganic fillers to make excellent sealing and caulking compounds. A typical "filler" would be:

Whiting	50%
Talc	30%
Lithopone	10%
7 M Asbestos	10%

By combining selected Aroclors and Indopol polybutenes, it is possible to produce a wide range of hardness, viscosity, flow and bonding characteristics in durable sealing and caulking compounds.

Excellent mastics, too, can be prepared by blending selected Aroclor resins with Indopol polybutenes. The mastics have good adhesive qualitites for specialized uses such as sealing of automobile body construction.

PERMANENT TACK COATINGS

Aroclors and Indopol polybutenes can be blended in a variety of proportions to make permanently tacky coatings. These coatings may be applied to fabric or paper to provide a permanently "sticky" surface. Insecticides, for example, can be blended into such coatings to make insect traps or insect barriers on tree trunks for tree foliage or fruit protection. These coatings can also be used for tapes and sign backing.

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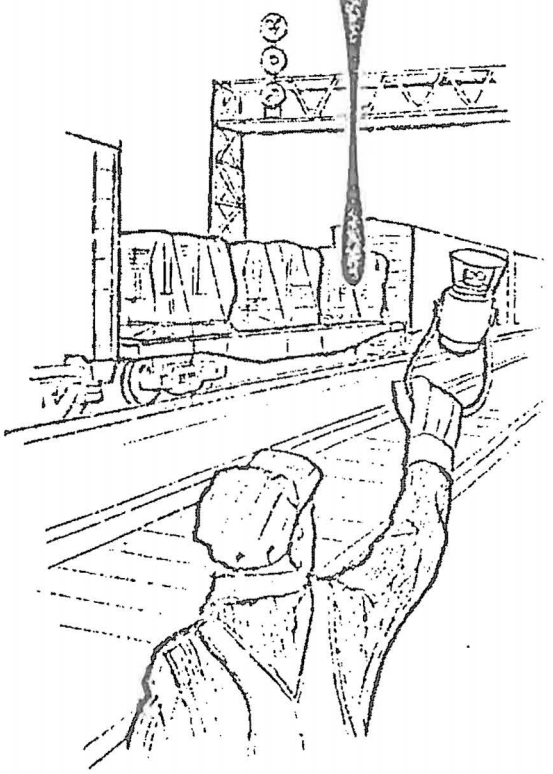
Aroclors are valuable as low cost plasticizers for a variety of applications. Aroclors improve chemical resistance, flame retardance, oxidation resistance, and reduce the cost of plasticized elastomers. Depending upon the use, the various Aroclor compounds offer a number of benefits to the user.

aroclors in plastics



In almost all formulations, the use of a selected Aroclor as a plasticizer reduces the cost per pound of the formulation.

Another valuable use of Aroclors in the plastics field is as a grinding and dispersing medium for pigments.

The Aroclor compounds are compatible with most common plastic materials; they are compatible to the extent of practical use with the following:

Asphalt
Benzyl Cellulose
Carnauba Wax
Cellulose Acetate Butyrate
Chlorinated Rubber
Coumarone-Indene Resins
Dammar Resin
Ester Gum
Ethyl Cellulose
Epoxy Resins
Manila Gum
Nitrocellulose
Paraffin
Phenolic Resins
Polyethylene
Polyester Resins
Polystyrene Resins
Polyiso-Butylene
Polyurethanes
Polyvinyl Acetate
Polyvinyl Chloride and
Polyvinyl Butyral
Polyvinylidene Chloride
Rosin
Rubber
Styrene Butadiene Co-Polymers
Vinyl Resins

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Aroclors are not compatible with cellulose acetate or with phenolic resins in the final stage of condensation.

In selecting the proper Aroclor for a given use, the degree of *flexibility* imparted increases progressively in the order of: hard resinous Aroclor, soft resinous Aroclor, liquid Aroclor. Conversely, the *hardness* of the plasticized elastomer increases progressively with the choice of: liquid Aroclor, soft resinous Aroclor, hard Aroclor resin.

POLYVINYL CHLORIDE

The Aroclors are valuable as secondary plasticizers, or plasticizer-extenders for polyvinyl chloride formulations. The Aroclors impart greatly improved chemical resistance over conventionally ester-plasticized compositions. For example, a formulation plasticized with 3 parts of DOP and 1 part of Aroclor 1254 shows the best chemical resistance of any plasticized polyvinyl chloride formulation evaluated to date.

Aroclor 1262, when used as a co-plasticizer with DOP, greatly reduces the amount of migration of the plasticizer to nitrocellulose lacquers. Aroclor 5460 is frequently used as a plasticizer-resin-extender to make flameproof vinyl tiling compositions.

In vinyl chloride co-polymer resins for solution application, the combination of Aroclor 5460 and Aroclor 1254 is widely used because of its outstanding chemical resistance.

RUBBER—NATURAL AND SYNTHETIC

The liquid Aroclor compounds — 1221, 1232, 1242 and 1248 — have a strong plasticizing action on rubber, both natural and synthetic. Aroclors 1254 and 1260,

when milled into rubber, impart permanent tackiness and adhesion to the composition.

Aroclors 2565, 4465, 5460 and 1268, when incorporated in neoprene rubber in amounts as high as 40 parts per 100 parts of rubber make compositions that are extremely flame retardant.

The Aroclors generally show a high degree of compatibility with epoxy resins; this group of materials is one of the very few plasticizers that possess such high compatibility with these materials. The lower Aroclor numbers, 1221 and 1232, impart a high degree of flexibilizing to epoxy compounds. The more resinous and solid Aroclors have little effect on the flexibility of the compound; in fact, they tend to act as reinforcing materials. Aroclors have little effect on epoxy resins' hardness, tensile or compressive yield strength. The ultimate compressive strength can be improved by using solid Aroclors in phthalic anhydride cured systems.

All of the Aroclors, when used at a rate of 15 to 20 parts per hundred of resin, greatly retard the burning rate of epoxy compositions. If a small amount of antimony oxide is added in addition to the Aroclor compounds, the materials then become non-burning.

Aroclor 5460, when used in low density polyethylene to the extent of 20% — in combination with 10% antimony oxide — makes the compound self extinguishing. Compared to other materials that make polyethylene self extinguishing, Aroclor 5460 has much less effect on tensile, yield and elongation properties. In addition, the heat stability of the Aroclor compound is greatly superior to the other materials commonly used to make polyethylene self-extinguishing.

Incorporation of the solid, resinous Aroclors will make asphalt self extinguishing. Possible applications of this type of formulation include caulking compounds, roofing compounds and sound-deadening coatings. Normally, 30% of an Aroclor such as 5460 will make an asphalt mixture that is self extinguishing.

Incorporation of Aroclor in a polyester resin in combination with antimony oxide greatly reduces the burning rate of polyester resins. A mixture of sufficient amounts of selective Aroclors will produce polyesters that are self extinguishing.

Considerable interest has been displayed in the use of Aroclors in phenolic laminating resins, to make compounds that are flame resistant. Normally, the higher molecular weight Aroclor, such as Aroclors 1260, 1262 and 5460 are evaluated for this purpose.

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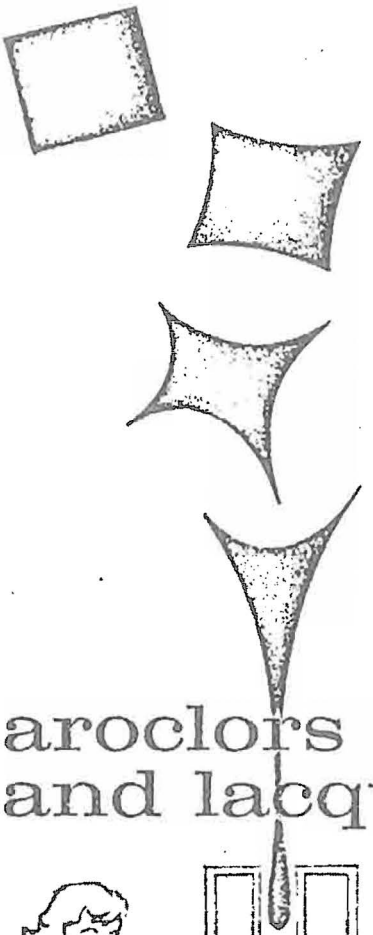

Aroclors are soluble in paint and varnish oils and solvents and are compatible with most film-forming coating resins. The Aroclor compounds improve adhesion to the substrate. Adding Aroclors to paint, varnish or lacquer formulations imparts properties to the film that correspond to the particular character of the Aroclor used. The hard, resinous Aroclors tend to give increased hardness to films; the viscous Aroclors impart flexibility.

Aroclors are excellent grinding and dispersion media for pigments used in paints and varnishes. Aroclor 1254 is used to disperse aluminum powder in a paste form which can be incorporated easily into paints and varnishes. The Aroclor imparts excellent leafing qualities, brightness or luster and does not tarnish the aluminum pigment on aging. Moreoever, the coating composition does not support combustion.

aroclors in paint, varnish and lacquer formulations

VARNISHES AND ALKYDS

Aroclors 4465 and 5460 will produce paints that are very quick drying and yet have excellent durability. The weight of Aroclor used may be from 30% to 50% of the weight of the oils.

The Aroclors do not react chemically with oils, hence there is no advantage in heating together in making a varnish. They are best added as a "chill back" or as a cold cut in the thinning operation. As far as incorporation of the Aroclors is concerned, the only reason for heating is to make the Aroclors liquid so they can be more readily mixed with the oils.

Aroclor 1260 is best for short oil varnishes that are required at the same time to be flexible. The Aroclors impart water and alkali resistance, and with these qualities enhance the value of the other resins used in the varnish. The suggested starting formulation is two parts by weight of oil, one part of Aroclor 1260 and one part of other resin. These

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Aroclor 1254 in yellow traffic paint.

proportions can be varied as required. The Aroclor may be considered to function in the formulation as an oil, with the difference that it does not oxidize and lose its flexibility.

Resins of the alkyd, phenolic or ester gum type, with a harder Aroclor such as 5460, may also be used in making varnish formulations.

EPOXY RESIN COATINGS

The high compatibility of Aroclor compounds with epoxy resins makes these materials of great value in formulating epoxy coatings. Normally, 10 to 15% of Aroclor 1260 or 1262 is added to the epoxy composition to improve flexibility with a minimum effect on the corrosion resistance and adhesive characteristics of the film.

NITROCELLULOSE COATINGS

In pyroxylin or nitrocellulose lacquers, the Aroclors can function both as plasticizers modifying the properties of the film and as film-forming bodying resins. Aroclors are highly compatible with nitrocellulose and with other resins and plasticizers commonly used in lacquer formulating. They impart weather resistance, luster, adhesion and decreased burning rate. The Aroclors' excellent electrical characteristics (high dielectric strength and resistivity and low power factor) and their property of retarding the passage of moisture and gases through nitrocellulose make the Aroclors of special value in coatings for electrical insulating materials.

To illustrate the modification possible to obtain by changes in formulation, three lacquer formulas are given below. All have excellent durability but the third is much softer and more flexible than the other two. Only the solids contents are given. The amounts tabulated are parts by weight.

Aroclor Lacquers

	No. 1	No. 2	No. 3
½ second Nitrocellulose (dry)	100	100	100
Dammar resin	80	—	—
Ester Gum	—	80	—
Aroclor 1260	20–39	20	80–70
Dibutyl Phthalate	20–0	20	—
Tricresyl Phosphate	—	—	39–70

No. 1 and No. 2 have excellent sanding and polishing qualities. No. 3 is very flexible but too soft for sanding.

Where extremely high flexibility is desired, as for example in lacquers for high tension automotive cables, the following composition is suggested:

15-20 second R. S. Nitrocellulose	100 parts by weight
Tricresyl Phosphate	120 parts by weight
Aroclor 1242	80 parts by weight

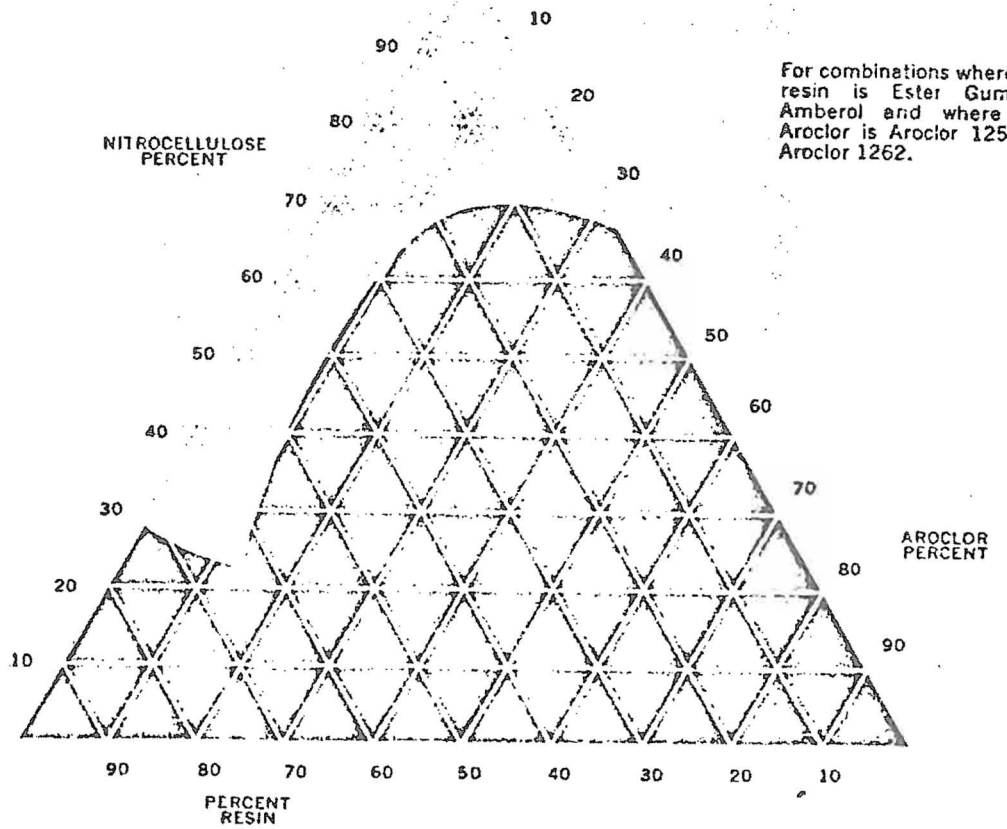
The accompanying trilinear diagrams show the practical compatibility limits of Aroclors 1254 and 1262 when used in combination with some other resins and plasticizers. Aroclor 1260 gives values almost the same as those shown for 1262. The less viscous Aroclors have greater compatibility; the more resinous Aroclors have less compatibility than the ones shown.

0509851

In the trilinear diagrams, the compositions, represented by any point in the unshaded areas, are those which produce homogeneous lacquer films. On the other hand compositions represented by points in the shaded areas produce impractical, segregated, brittle or soft films. For detailed information as to the derivation and use of these diagrams reference is made to the following articles:

Jenkins & Foster, "Compatibility Relationships of the Aroclors in Nitrocellulose Lacquers," Ind. Eng. Chem. 23, 1362 (1931).

Hofmann & Reid, "Graphical Methods in Lacquer Technology," Ind. Eng. Chem. 20, 431 (1928); "Formulation of Nitrocellulose Lacquers," Ind. Eng. Chem. 20, 687 (1928).



For combinations where the resin is Ester Gum or Amberol and where the Aroclor is Aroclor 1254 or Aroclor 1262.

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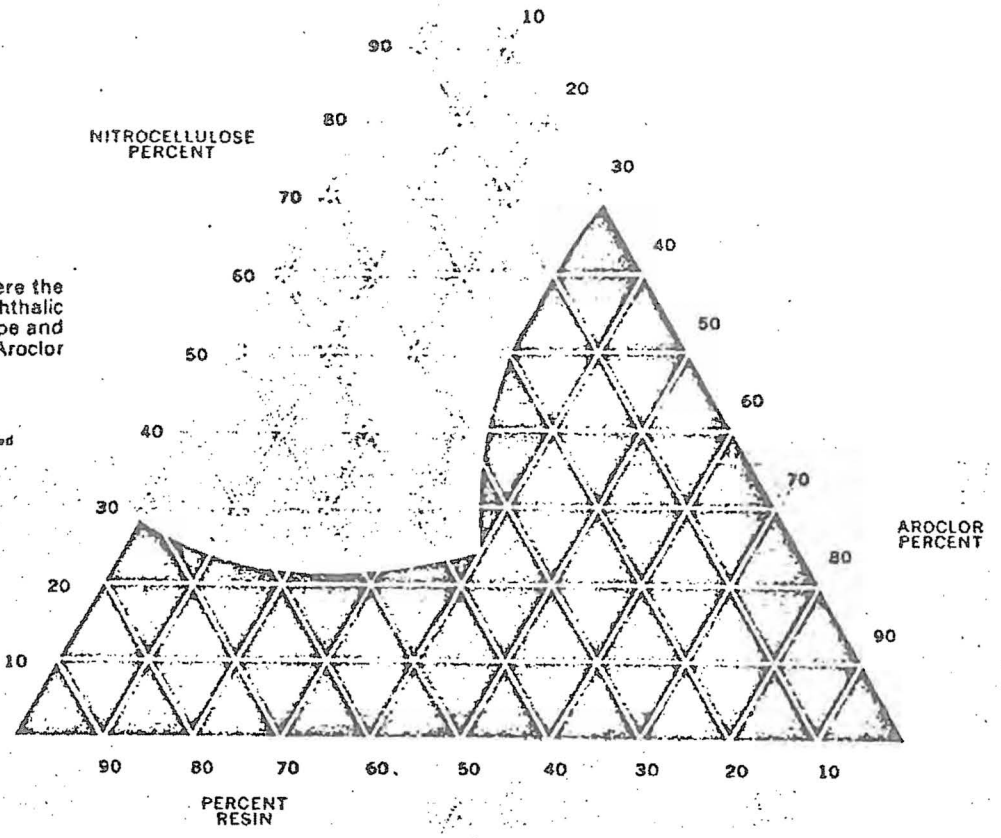
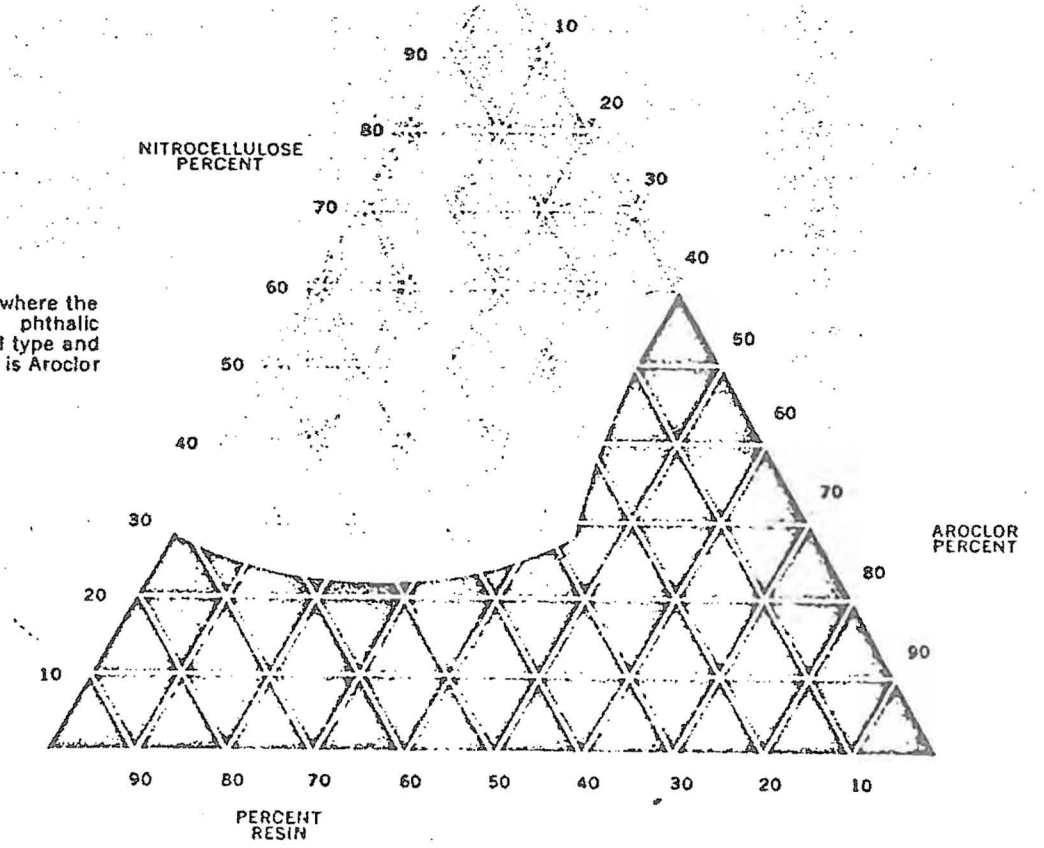
For combinations where the resin is of the phthalic anhydride-glucerol type and where the Aroclor is Aroclor 1262.[a]

[a]Aroclor 1260 may be substituted without material change.



For combinations where the resin is of the phthalic anhydride-glycerol type and where the Aroclor is Aroclor 1254.



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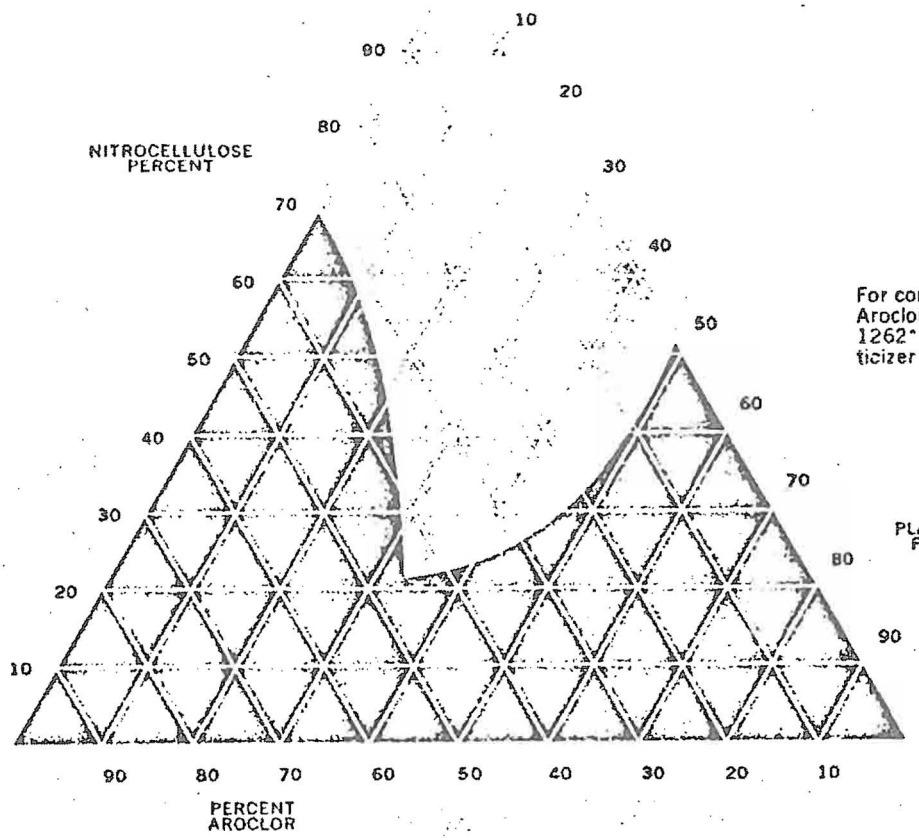
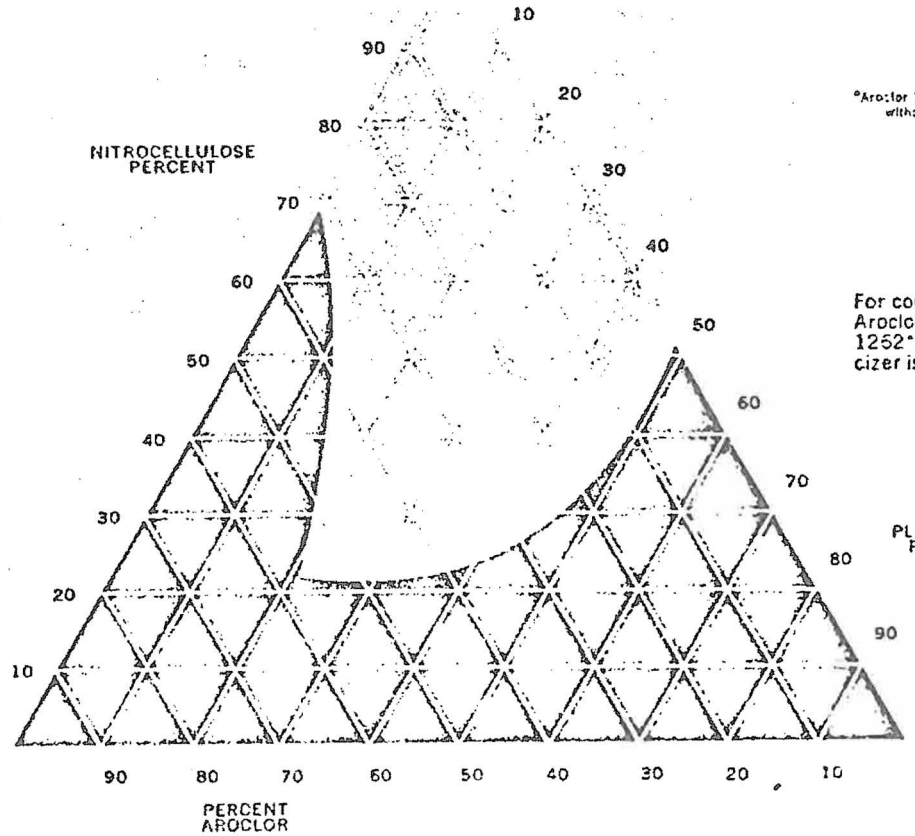


For combinations where the Aroclor resin is Aroclor 1262* and where the plasticizer is Dibutyl Phthalate.



*Aroclor 1260 may be substituted without material change.

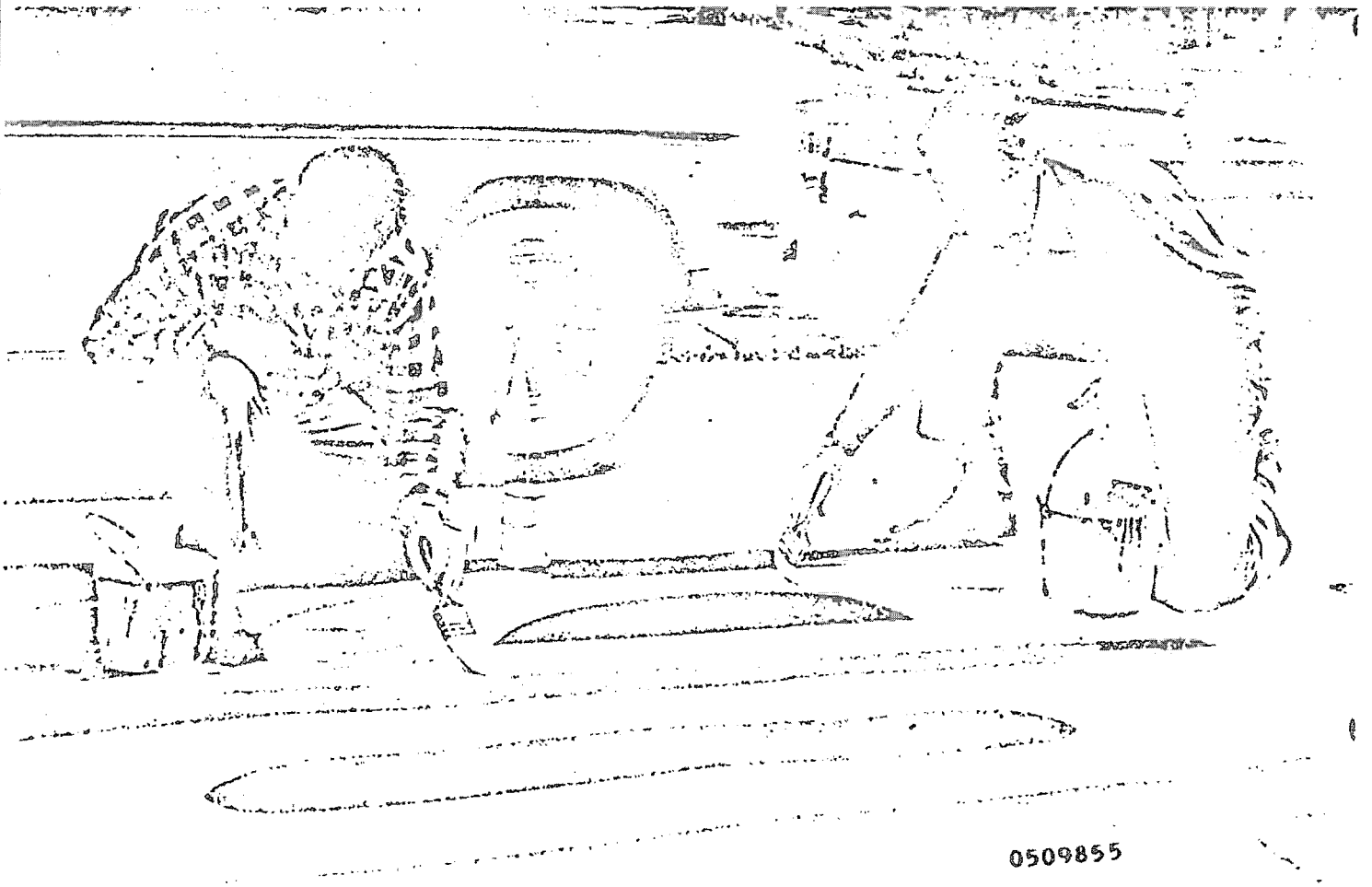
For combinations where the Aroclor resin is Aroclor 1252* and where the plasticizer is Tricresyl Phosphate.

0509854

CHLORINATED RUBBER AND STYRENE-BUTADIENE COPOLYMERS

Aroclors are outstanding for compounding modified rubber finishes. They impart exceptional corrosion resistance, chemical resistance, oxidation resistance to these coatings, and improve adhesion. Typical applications include masonry coatings for swimming pools, stucco homes and highway paints, as well as protective and decorative coatings for steel structures, railway tank and gondola cars, wood and metal maritime equipment.

In rubber base coatings, Aroclor 1254 is used as a liquid flexibilizing plasticizer and commonly used in combination with Aroclor 5460 which serves as a resin fortifier. The outstanding chemical resistance, corrosion resistance and oxidation resistance of rubber base Aroclor coatings make them outstanding protective coatings for chemical plants, boats, highway marking, and masonry. Monsanto Technical Bulletins No. PL-306, PL-311, and PL-326 cover the use of Aroclors in rubber-base coatings.



CELLULOSE ACETATE-BUTYRATE LACQUERS

The higher Aroclor compounds are widely used with cellulose acetate butyrate, in the manufacture of low-cost lacquers that are flame resistant. Typical uses for this type of lacquer include paper coating, lacquers for plastics and strippable coatings for paint booths.

A typical paper lacquer with minimum tendency to curl is reported* to contain the following:

	By Weight
Half-second Butyrate	20%
Aroclor 1260	20%
Acetone	10%
Isobutyl Acetate	10%
Ethyl Alcohol	10%
Toluene	30%

ETHYL CELLULOSE COATINGS

The Aroclors are highly compatible with ethyl cellulose. The liquid Aroclors impart great flexibility, the resinous Aroclors impart great hardness. For example, 75 parts by weight of Aroclor 1242 with 100 parts of ethyl cellulose produces great flexibility and a slight tackiness. Aroclor 5460 on the other hand — in the same proportion — produces a very hard and somewhat brittle composition.

For coatings of high gloss and exceptional weathering properties to be applied to rigid surfaces, compositions containing equal parts by weight of Aroclor 5460 and ethyl cellulose are recommended. For more flexibility in the coating one of the softer Aroclors should be used — either alone or as a partial replacement for the Aroclor 5460.

Ethyl cellulose formulations plasticized with Aroclors find end use applications as protective lacquers, adhesives, and as strippable coatings.

The solid Aroclor compounds, such as Aroclor 5460 are widely used in hot melt applications for the protection of tools and metal parts. They are normally used with ethyl cellulose or cellulose acetate-butyrate resins.

CREPE RUBBER COATINGS

Aroclor 1262 is used as a low cost plasticizer for crepe rubber in paint compositions. Used in concentrations of 5 to 50% based on the weight of the rubber polymer, it increases the gloss and alkali resistance of the film and strengthens the adhesion of the film to steel.

*W. M. Gearhaert and F. M. Ball, OFFICIAL DIGEST, Vol. 343, 1953.

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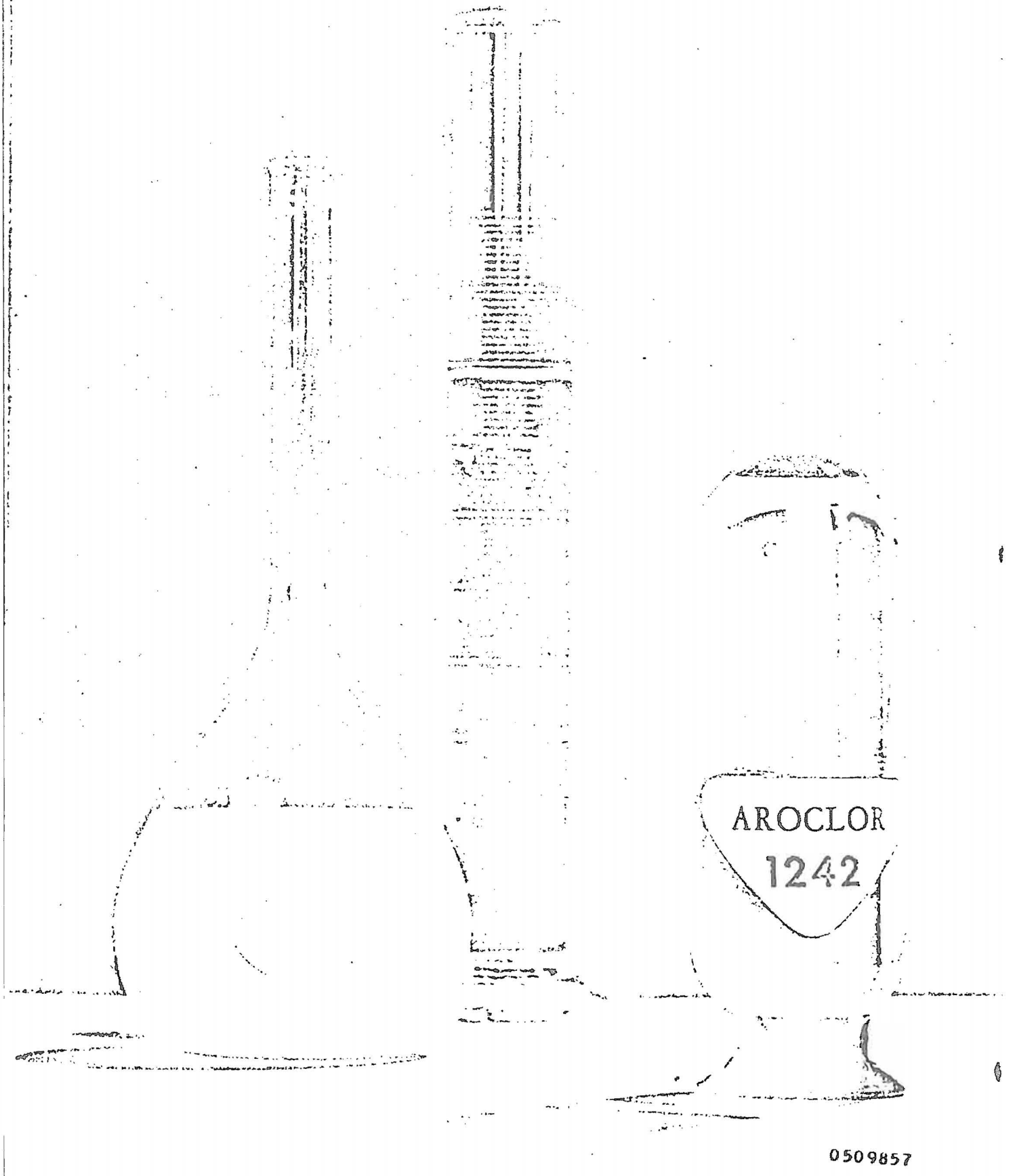
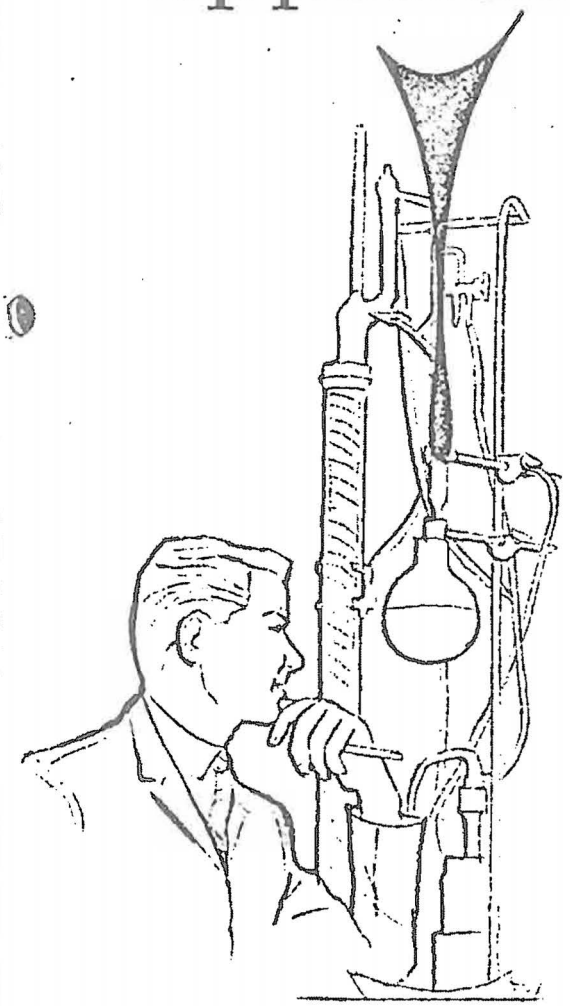

AROCLOR
1242
0509857

appendix



METHODS FOR EMULSIFYING AND MAKING STOCK SOLUTIONS OF AROCLORS

There are several simple methods for making Aroclor emulsions; the one used may be selected to suit the kind of Aroclor and type of formulation in which it will be used.

Emulsifying Viscous Aroclors

(Portion 1)	16 lbs. of Aroclor 1 lb. of Stearic Acid
(Portion 2)	8 lbs. of water 4 oz. Triethanolamine

Heat the Aroclor to a workable viscosity (180°F plus) and stir in the stearic acid thoroughly. Heat the water to almost boiling (207°F) and stir in the triethanolamine thoroughly. Pour the Aroclor-stearic acid portion *into* the water portion agitating vigorously. Then process the combined portions with a high-speed emulsifying stirrer . . . or process through a colloid mill.

Emulsifying Liquid Aroclors

(Portion 1)	100 parts Aroclor 1254 4 parts Oleic Acid
(Portion 2)	92 parts water 2 parts Ammonium Hydroxide (28%) 2 parts Lustrex° X-810

Mix the ammonium hydroxide and Lustrex X-810 thoroughly in the warmed water, using vigorous agitation. Mix the Aroclor 1254 and Oleic Acid, heat to 45°C and agitate vigorously. Maintain the 45°C temperature and agitation — and add in *slowly* the water portion. Continue agitation for one-half hour till phase inversion is complete.

Emulsifiable Concentrated Stock Solutions of Aroclors

79 parts of Aroclor
16.70 parts of toluene
3.55 parts of isopropyl alcohol
1.00 parts of Sterox° CD (non-ionic emulsifier)
0.75 parts of Santomerse° #3 (anionic wetting agent)

The above formulation is readily emulsifiable with water. If the more resinous Aroclors are used, increase the amount of toluene (or xylene) as needed to dissolve the Aroclor resin.

°Trademarks Monsanto Chemical Co., Reg. U. S. Pat. Off.

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SOLUBILITY OF AROCLORS IN 100 MILLILITERS OF VARIOUS SOLVENTS

Aroclor	1242		1248		1254		4465		5460
Type of Solvent	25°C	Hot	25°C	Hot	25°C	Hot	Cold	Hot	25°C
Acid									
Acetic Acid	S	S	—	—	S	S	SS	S	—
Oleic Acid	S	S	—	—	S	S	S	VS	—
Benzoic Acid	10.0 31°C	—	10.0 32°C	—	—	—	—	—	—
Aldehyde									
40% Formaldehyde	I	I	I	I	I	I	I	I	—
Furfural	VS	VS	VS	VS	VS	VS	VS	VS	—
Amine									
Aniline	S	S	—	—	S	S	VS	VS	—
Pyridine	132.5 30°C	440 99°C	—	—	114 31°C	425 100°C	VS	VS	—
Chloro—derivatives									
Amyl chlorides—mixed	S	S	S	S	S	S	VS	VS	—
Carbon Tetrachloride	S	S	S	S	S	S	VS	VS	156
Chloroform	S	S	S	S	S	S	VS	VS	—
Dichlorethylene	—	—	—	—	—	—	VS	VS	—
Ethylene Dichloride	S	S	S	S	S	S	VS	VS	—
Monochlorobenzene	S	S	S	S	S	S	VS	VS	—
Orthodichlorobenzene	—	—	—	—	—	—	VS	VS	—
Tetrachlorethane	S	S	S	S	S	S	VS	VS	—
Trichlorethane	S	S	S	S	S	S	VS	VS	—
Trichlorethylene	S	S	S	S	S	S	VS	VS	—
Drying Oil									
Tung Oil	S	S	S	S	S	S	VS	VS	—
Linseed Oil	S	S	S	S	S	S	VS	VS	—
Ester									
Amyl Acetate	S	S	S	S	S	S	VS	VS	—
Butyl Acetate	S	S	S	S	S	S	VS	VS	—
Cellosolve Acetate	S	S	S	S	S	S	VS	VS	—
Cottonseed Oil	S	S	S	S	S	S	S	VS	—
Dibutyl Phthalate	S	S	S	S	S	S	S	VS	—
Diethyl Phthalate	S	S	S	S	S	S	S	VS	—
Ethyl Acetate	S	S	S	S	S	S	S	VS	—
Ethyl Lactate	S	S	S	S	S	S	VS	VS	—
Ethylene Glycol Diacetate	S	S	S	S	S	S	VS	VS	—
Methyl Acetate	S	S	S	S	S	S	S	S	—
Tricresyl Phosphate	S	S	S	S	S	S	SS	S	—
Ether: Ethyl Ether	S	S	S	S	S	S	S	—	—
Ether Alcohol									
Carbitol	224 31°C	307 99°C	VS	VS	173 26°C	259 98°C	SS	—	—
Cellosolve	S	S	S	S	S	S	S	—	—
Diethylene Glycol	—	—	—	—	—	—	S	—	—
p-p' Dihydroxy Ethyl Ether	16.9 23°C	19 99°C	SS	SS	8 30°C	10 100°C	SS	—	—
Hydrocarbon									
Benzene	VS	VS	VS	VS	VS	VS	VS	VS	143
Gasoline	VS	VS	VS	VS	VS	VS	VS	VS	—
Kerosene	VS	VS	VS	VS	VS	VS	VS	VS	—
Mineral Spirits	VS	VS	VS	VS	VS	VS	VS	VS	—
Paraffin	2.0 27.5°C	S	2.0 26°C	S	—	S	<5.0	S	—
Pine Oil	S	S	VS	VS	S	S	S	S	—
Toluene	VS	VS	VS	VS	VS	VS	VS	VS	142
Turpentine	VS	VS	VS	VS	VS	VS	VS	VS	—
Xylene	VS	VS	VS	VS	VS	VS	VS	VS	178
Hydroxy—derivatives									
Amyl Alcohol	S	S	—	—	S	S	S	S	—
n-Butyl Alcohol	S	S	—	—	S	S	SS	S	—
Ethyl Alcohol (3-A)	23.3 29°C	80.0 70°C	—	—	10 27°C	28 75°C	SS	—	—
Glycerine	I	I	I	I	I	I	I	I	—
Methyl Alcohol	42.5 29°C	88.5 60°C	—	—	15 26°C	22.2 65°C	SS	—	—
Phenol—90%	194 30°C	S	—	—	SS	S	S	S	—
Ketone									
Acetone	S	S	—	—	S	S	S	S	260
Miscellaneous									
Carbon Disulfide	S	S	—	—	S	S	VS	VS	—
Nitrobenzene	S	S	—	—	S	S	VS	—	—
Water	I	I	I	I	I	I	I	I	—

I—Insoluble S—Soluble SS—Slightly Soluble VS—Very Soluble

Figures show grams of Aroclor per 100 milliliters of solvent at 25°C unless otherwise indicated.

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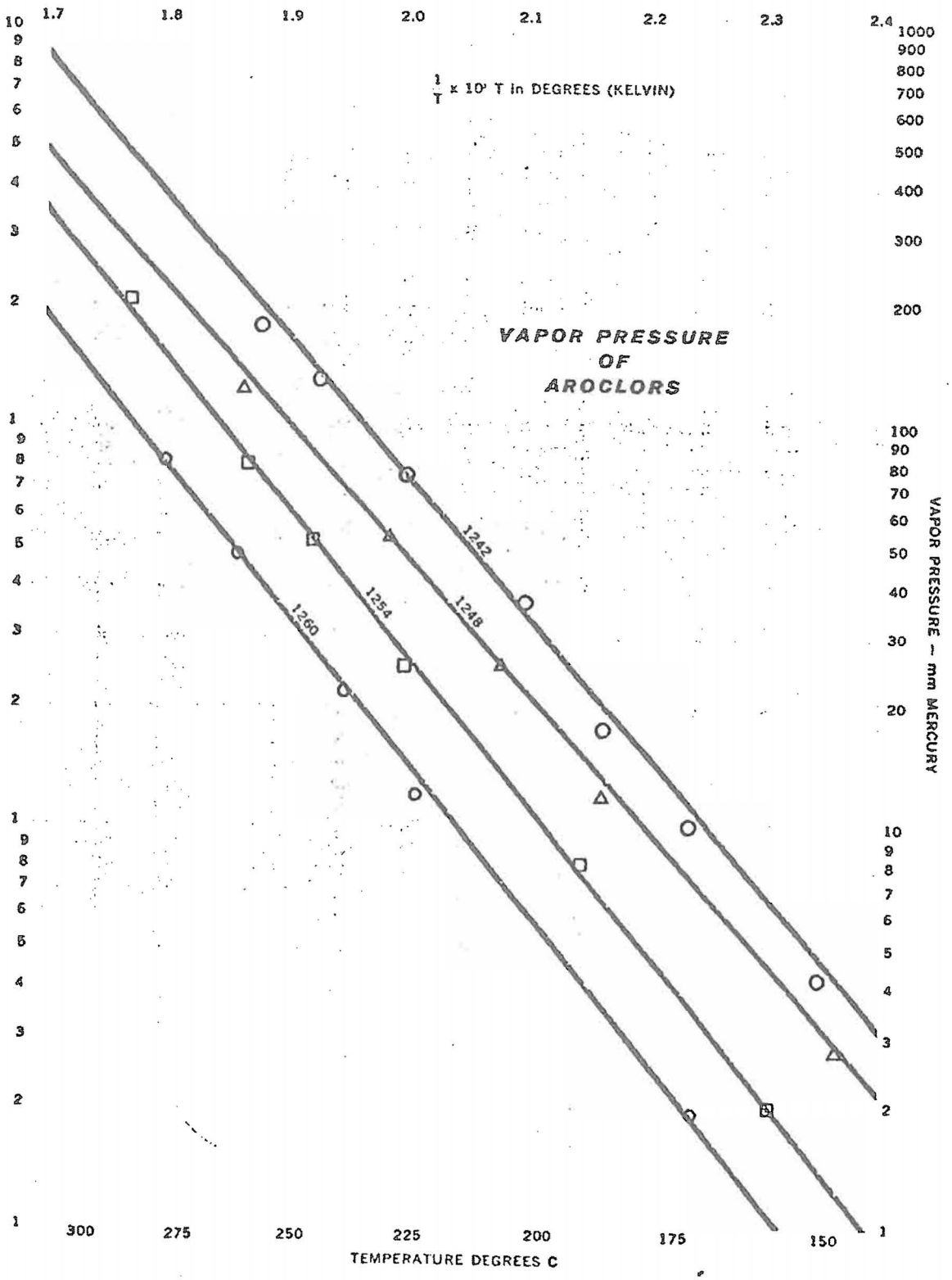

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VAPORIZATION RATES

At 100°C and 760 mm. Hg.

Sample	Wt. Loss Gms.	Hours Exposure	Surface Area Cm.²	Vaporization Rate gms./cm.²hr.
Aroclor 1221	0.5125	24	12.28	0.00174
Aroclor 1232	0.2572	24	12.28	0.000874
Aroclor 1242	0.0995	24	12.28	0.000338
Aroclor 1248	0.0448	24	12.28	0.000152
Clorafin-42-S	0.0745	48	12.28	0.000126
DOP (dioctyl phthalate)	0.0686	48	12.28	0.000117
Dutrex 25	0.0256	24	12.28	0.000087
Aroclor 1254	0.0156	24	12.28	0.000053
Dutrex 20	0.0047	24	12.28	0.000016
Aroclor 1262	0.0039	24	12.28	0.000013
Aroclor 1260	0.0026	24	12.28	0.000009
Aroclor 4465	0.0064	72	12.28	0.000007
Aroclor 1270	0.0045	72	12.28	0.000005
Aroclor 5442	0.0039	72	12.28	0.000004
Aroclor 5460	0.0032	72	12.28	0.000004
Tricresyl phosphate	0.0010	24	12.28	0.000003

APPROXIMATE VAPOR PRESSURES
CALCULATED AT 100° F (37.8° C)

Aroclor 1232	0.005 mm. Hg.
Aroclor 1242	0.001 mm. Hg.
Aroclor 1248	0.00037 mm. Hg.
Aroclor 1254	0.00006 mm. Hg.

0509861

RESISTANCE OF STRUCTURAL MATERIALS TO AROCLORS

Metals	Arochlor Number 1248 25°C	1248 125°C	1254 25°C	1254 125°C	4465 125°C	5460 125°C
Aluminum	R	R	R	R	°RR	RR
Copper	R	D	R	D	D	D
Magnesium	RR	R	R	R	RR	°RR
Nickel	RR	R	R	RR	RR	R
Silver	R	R	R	R	R	R
Tin	R	R	R	R	R	R
Zinc	R	R	R	R	R	RR
Mild Steel	RR	R	RR	RR	R	RR
Phosphor Bronze	R	D	R	R	R	R
Red Brass	D	D	R	D	R	De
Stainless Steel (Type 316)	RR	RR	RR	RR	RR	RR
Yellow Brass	R	Re	R	De	Re	Re
Plastics						
Alkyd Resin No. 46594-12	°P	P	°P	P	P	P
Alkyd Resin No. 46594-13A	°D	P	°D	P	P	P
Cellulose Acetate (Fibestos)	D	P	D	P	P	P
Durite Phenol Furfural Resin	°D	P	°R	P	D	P
Formvar Highly Plasticized	De	T	Pe	T	T	T
Formvar Low Plasticized	PS	T	PS	T	T	T
Glyptal 1276	R	P	D	P	P	P
Glyptal 7136	°D	T	°R	T	T	T
Maleic Resin No. 46594-13B	P	P	°P	P	P	P
Maleic Resin No. 46594-13C	P	P	°R	P	P	P
Plexiglas (Methyl Methacrylate)	°D	P	°D	P	P	P
Polystyrene (Lustron B)	P	T	P	T	T	T
Resinox Mineral Filled Melamine Resin	°D	°P	°R	R	°P	°D
Resinox Wood Flour Filled Melamine Resin	°D	P	°R	D	R	P
Resinox Mineral Filled Phenol Formaldehyde	°D	D	°D	D	R	P
Resinox Wood Flour Filled Phenol Formaldehyde	°D	P	°D	°R	D	P
Resinox Rag Filled Phenol Formaldehyde	°D	D	°D	°D	°D	P
Urea Formaldehyde Resin (Plaskon Co.)	°D	P	°D	°P	P	P

Meaning of Abbreviations:

°—Based on weight gain calculated as penetration value shown.

RR—Excellent resistance—less than 1.0×10^{-6} cm/day penetration or .00014 in/yr.

R—Good resistance—has penetration between 1.0×10^{-6} and 10×10^{-6} cm/day or between 0.00014 and 0.0014 in/yr.

D—Doubtful resistance, penetration between 10×10^{-6} cm/day and 100×10^{-6} cm/day or between 0.0014 and 0.014 in/yr.

P—Poor resistance—penetration greater than 100×10^{-6} cm/day or 0.014 in/yr.

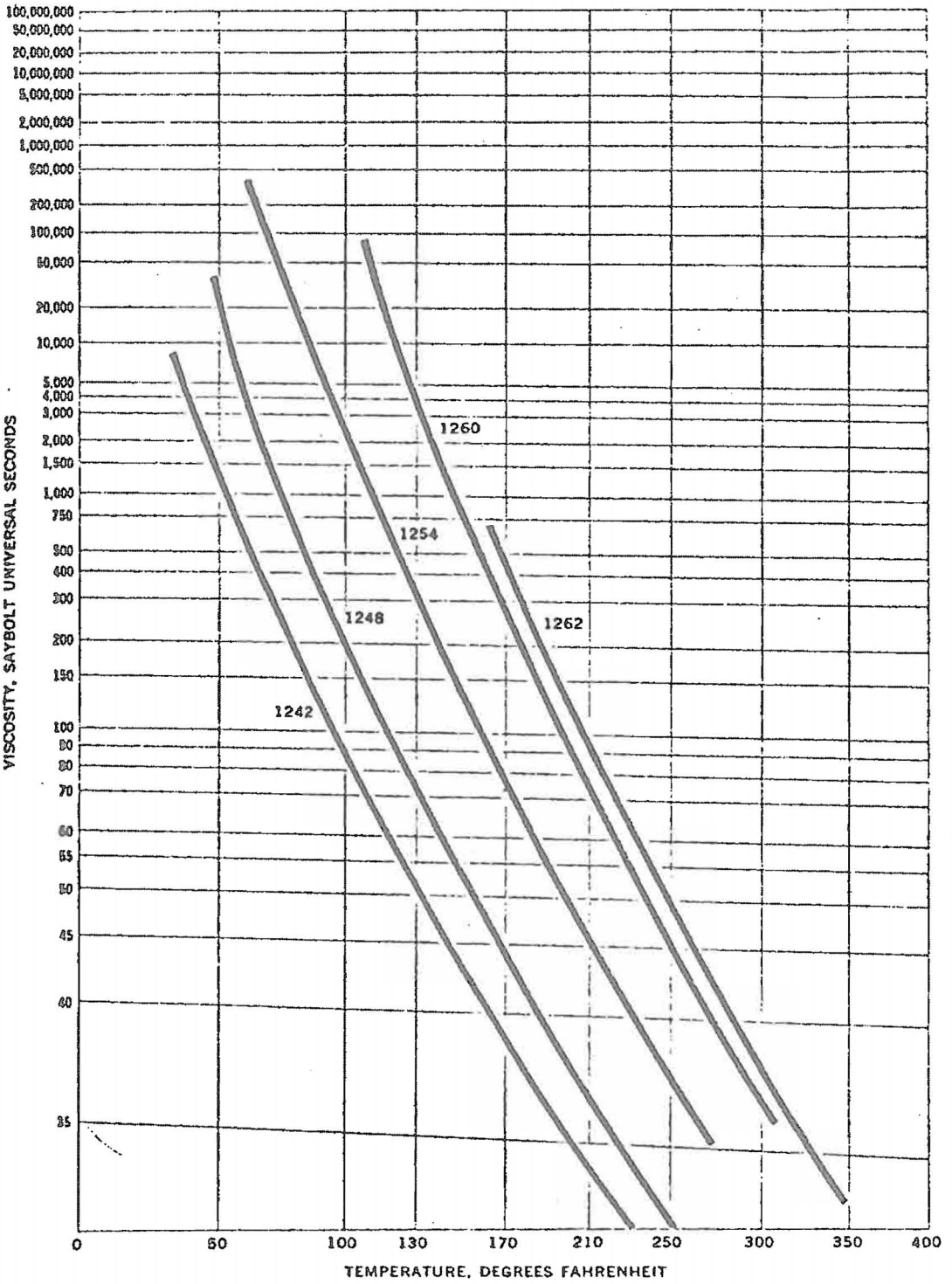
PS—Poor resistance due to visible local action although weight change indicates greater resistance.

e—Following the letter indicating resistance signifies material may be better than indicated if totally immersed since weight loss is believed to come from oxidation of the part of test strip exposed to air.

T—Material alone will not stand temperature.

0509862

VISCOSITY RANGES OF SOME OF THE AROCLORS



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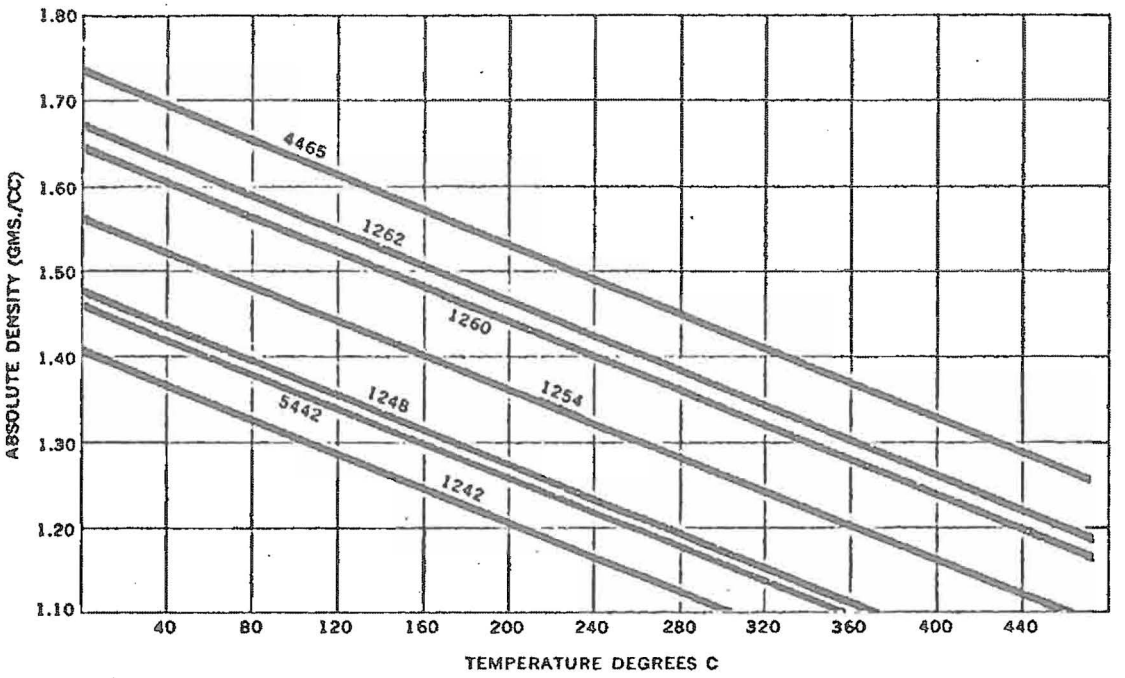
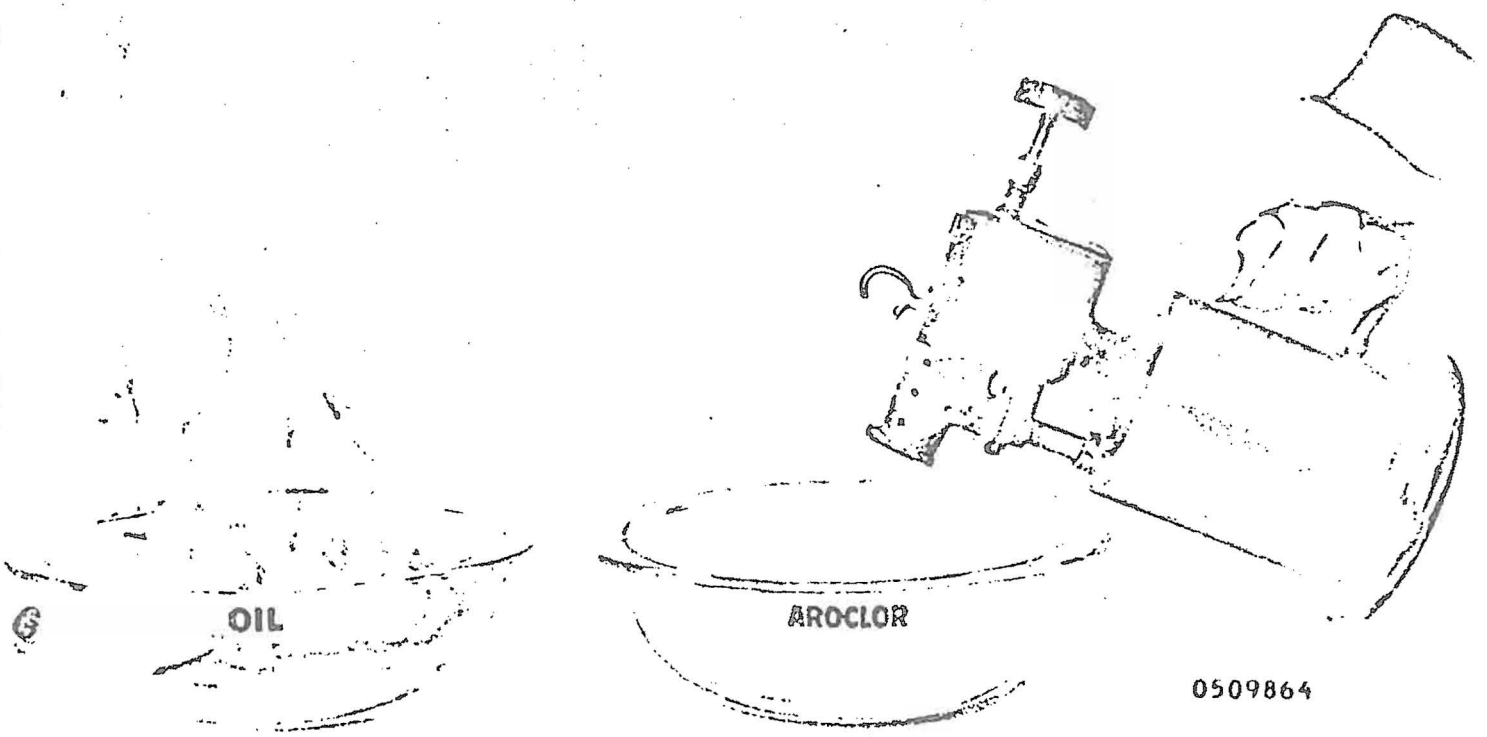
DENSITIES OF AROCLORS AT VARIOUS TEMPERATURES





At ordinary temperatures Aroclors have not presented industrial toxicological problems. Where Aroclor vapors may be encountered in workrooms, local exhaust ventilation together with general workroom exhaust is recommended.

Skin patch tests with a polyvinyl chloride free film plasticized with 11.5% by weight of Aroclor 1254 (about 25% based on the weight of the vinyl resin) and a similar amount of dioctyl phthalate showed that this film was not a primary irritant or a sensitizer. Skin patch tests with Aroclor 1254 alone applied to gauze and placed in contact with the skin showed no primary irritancy or sensitization. Other skin patch tests using canvas coated with Aroclor 5460 and an oil modified alkyd resin, in such a manner that the Aroclor concentration in the paint film on the fabric was about 17% by weight of paint solids and the finished coated fabric contained approximately 7% by weight of Aroclor 5460 showed that this painted fabric did not produce a primary irritancy or sensitization of the skin.

If Aroclors are spilled on the skin, the skin should be washed in the usual manner with soap solutions. If accidental burns occur from contact with hot Aroclors, the burn should be treated the same as any ordinary burn. Aroclor adhering to the burned area need not be removed immediately unless treatment of the burn demands it, in which case use soap and water or repeated washings with a vegetable oil.

Monsanto

0509865

fire retardant
inert
shear resistant
heat stable
lubricating

aroclors for...

physically "adjustable"
adhesive
non-volatile
low cost
thermoplastic

FILM FORMING
IMPREGNATING
INSULATING
HEAT TRANSFER
DEDUSTING
INERT MATRIXES
PLASTICIZING
BULKING
COATING
"TACKIFYING"
REDUCING VOLATILITY

Aroclors are the only low cost, inert, inter-compatible liquids and solids whose intermixing can provide insulating, lubricating, fire retardant liquids ranging from the consistency of light mineral oil to the most viscous syrup (or solid resin) which will do so many jobs in industry.

Division • 800 North Lindbergh Blvd. • St. Louis 66, Missouri

0509866

2-500-55/60-53

Exhibit 15

PLASTICIZER SALES DEPARTMENT

PLASTICIZER PATTER

Monsanto

J. R. Darby
Res-JFQ

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS 24, MISSOURI

February, 1961

END USES FOR AROCLOR COMPOUNDS

INDEX

FOR SALESMEN'S USE ONLY

END USES FOR AROCLOR COMPOUNDS

GENERAL

You remember some time ago you cooperated with us in supplying information about where your customers are using Aroclor compounds and the reasons why they were using them. This survey covered all accounts that purchased over 5,000 pounds of Aroclor annually. Your aid in this project was deeply appreciated. We have now compiled these results and this is the way it stacks up. We hope this will be useful to you in suggesting new uses or applications for the Aroclors and increasing your sales of these products.

SURFACE COATINGS are the largest single outlet for the Aroclor compounds. The adhesion, cost, chemical resistance, and flame resistance of these Aroclors are of tremendous importance.

The ADHESIVES Industry also consumes large quantities of Aroclors. In the adhesive field the adhesion, cost, and flame retardancy are the three most commonly mentioned reasons for the use of these products.

The PLASTICS Industry also consumes sizeable quantities of Aroclors depending upon the type of end application. The reasons most commonly mentioned for using the Aroclors are adhesion, cost, flame retardancy.

The miscellaneous category includes all types of applications, some of which are large, some of which are very small. However, we have outlined these applications in the attached sheets.

The attached write-ups are for your own use only, and not to be shown to customers. You will note we have shown four categories in order to give you an idea of our volume in each field. The break down on these is shown below.

Large	500,000 pounds and over
Good	250,000 - 500,000 pounds annually
Fair	100,000 - 250,000 pounds annually
Minor	Less than 100,000 pounds annually

You will note a practical potential figure. This is an indication of the number of times we could probably expand our participation in this field with effort.

We have shown products used. These are in descending order of use in the field of application.

We have shown the number of customers for each particular application and the number of bulk and truckload customers to give you a better understanding of the field; as well as the number of times a reason for using the Aroclors appeared in this particular field.

In addition to giving you a summary page on the entire field, we are backing this up with a list of patents that have appeared in each field and slants from your call reports. We hope this will aid you greatly in getting a better understanding of the Aroclor field, plus aiding you in your sell-more Aroclor program.

SURFACE COATINGS

TYPE	VOLUME	POTENTIAL	AROCLOR PRODUCTS USED	# Customers	# Bulk or TL Cost	Adhesion	Cost	Oxidation	Chem. or Corrosion Resistance	Flame Resistance	Melt Point	Viscosity	Extraction	Water Resistance
Chlorinated Rubber	Large	1.5	1252, 5460, 1260, 1248, 1242	31	5	7	13	4	13	6	1	5	4	-
Nitrocellulose	Large	2	1254, 5460, 1260, 4465	13	1	4	12	2	--	1	-	-	1	1
Polyvinyl Chloride	Large	3	1254, 5460, 1260	7	3	2	3	-	4	4	-	-	-	-
Styrene-Butadiene	Good	6	5460, 1254, 1242	10	1	2	2	-	-	3	-	1	-	1
Epoxy	Fair	5	1242, 1260, 1254 1248, 1268, 5460	7	0	3	6	-	3	2	-	1	1	-
Silicone	Minor	5	1242, 5460, 4465	3	0	-	-	-	-	-	-	-	-	-
Polyvinyl Acetate	Minor	5	1260, 1254, 5460	4	0	4	3	-	-	2	-	-	-	-
Asphalt	Minor	10	1254, 1248, 1260	3	0	2	1	1	1	1	1	1	1	-
Phenolic	Minor	5	5460, 4465	3	0	2	1	-	1	2	-	-	2	-
Alkyd	Minor	10	1254, 5460	2	0	1	1	-	1	1	-	1	-	-
CA/Bu	Minor	15	4465, 5460	1	0	-	1	-	-	1	-	-	-	-
Ethyl Cellulose	Minor	20	1260	1	0	-	-	1	-	-	-	1	-	-

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CHLORINATED RUBBER

Chlorinated rubber (Parlon) is used in many fields of applications. Of the thirty-one accounts, we find that chemical resistance coatings, and masonry paints are the two most common uses. However, traffic paints, marine type paints, and shingle coatings also get a good play in this field.

A FLAME-RESISTANT, WATERPROOFING impregnating compound for asbestos cloth used in locomotive cabs contains chlorinated rubber, an Aroclor compound, and a wax. U.S.P. 2,145,235 by Robert E. Cryor assigned to Union Asbestos and Rubber Company, Chicago, Illinois.

Liquid Aroclor Compounds plus chlorinated rubber and pigments are used in a coating to protect and COLOR CONCRETE. U.S.P. 2,306,570 by Edward W. Scripture Jr., Skaker Heights, Ohio.

NITROCELLULOSE COATINGS

We find that our Aroclor compounds are being sold in Nitrocellulose lacquers for the following applications.

1. Electrical Appliance cable finish for dielectric properties of the finished cable.
2. Heel lacquers for women's shoes.
3. Lacquers for fiber seat covers for automobiles.
4. Overprint varnishes.
5. Wire cable coatings.
6. Metallic lacquers.

While Nitrocellulose is an old product, there are constantly new applications for the use of Aroclors popping up in this field.

POLYVINYL CHLORIDE

In totaling up the amount of Aroclors sold in polyvinyl chloride surface coatings, we were surprised to find that it was so large. Among the interesting applications are flame proof acoustical tile finishes and metal coatings where the Aroclor contributes adhesion.

A COATING FOR BARRELS and similar metallic surfaces composed of a vinyl chloride/vinyl acetate copolymer, an Aroclor compound, plasticizer and pigments. U.S.P. 2,111,395 by Otto J. Hartwick assigned to Pittsburgh Plate Glass Company, a corporation of Pennsylvania.

A METAL COATING that can be later pressed and formed has a finish lacquer over it for chemical resistance composed of polyvinyl chloride and an Aroclor compound dissolved in suitable solvents. U.S.P. 2,293,420 by Geory Wick, seized by Alien Property Custodian.

AN ELECTRICAL INSULATING MATERIAL for exposed bus bars comprised of a vinyl chloride/vinyl acetate copolymer, Tricresyl Phosphate, an Aroclor compound, and stabilizer. U.S.P. 2,183,811 by Edward C. Homan assigned to Irvington Varnish and Insulator Company, Irvington, New Jersey.

AN IMPREGNATING AND INSULATING MATERIAL for filling interstices for embedding or covering objects is composed of a small amount of polyvinyl-carbozole and a large amount of an Aroclor compound. U.S.P. 2,227,637 by Rudolf Engelhardt assigned to I. G. Farbenindustrie Aktiengesellschoft, Frankfort-on-the-Main, Germany.

A METAL COATING composition capable of being bent after baking is composed of a vinyl chloride/vinyl acetate copolymer and an Aroclor compound dissolved in suitable solvents. U.S.P. 2,115,214 by Clifford Jay Rolle- assigned to Ault and Wiborg Corporation, New York, New York.

STYRENE-BUTADIENE

In Styrene Butadiene coatings, which are commonly used in masonry paints, and metal paints we find one unique characteristic of the Aroclor compounds is their improved anti-tarnish characteristic compared to Chlorinated Paraffins when metallic pigments are used.

RANDY GRAHAM reports the reason they switched from Chlorowax to Aroclors 1254 and 5460 in their Pliolite S-5 traffic paint was because Chlorowax 70 precipitated from the formulation. When the paint was applied the precipi-tated Chlorowax was pressed out of the film and it affected the drying time. He talked with Goodyear about this problem and they ran a series of tests. Their findings verified test results which he had obtained where precipitation of Chlorowax took place. He said Goodyear's new technical bulletin will probably call for Aroclors in Pliolite formulations for traffic paints.

EPOXY RESINS

As you know, we have a big push on for the use of Aroclor compounds in epoxy plastics and surface coatings. Shown below are three references which may be of value to you.

JOE HENNINGER contacted Mr. _____ to follow up his purchase of 300 pounds of Aroclor 5460 in late November. This material is being used in epoxy resin coatings. Mr. _____ said that he very much approves of the flaked material over the old Aroclor 5460 which he had previously evaluated.

ED FORDING reports a customer using Aroclor 1254 in self-extinguishing epoxy coatings. The Aroclor 1254 produces an excellent gloss with a great depth.

They are currently using Aroclor and Mod Epox in an epoxy terrazzo. JOHN ELWOOD says that this is a relatively new product with them and seems to be going over very well. They expect their purchases to increase greatly in 1961.

POLYVINYL ACETATE

In polyvinyl acetate coatings the Aroclor compounds are used primarily in concrete or stucco paints plus one account that is using them in a paper coating.

ASPHALT COATINGS

In the asphalt coating field the Aroclor surface coatings are used primarily to impart flame retardancy and good corrosion resistance

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JOHN LONSBERG has an account that uses Aroclor 1254 in conn coatings on pipes, underground and above ground.

PHENOLIC SURFACE COATINGS

Phenolic surface coatings seem to find their greatest play in masonry and marine coatings.

JIM COMPTON reports that a p-tert-amyl phenolic type marine varnish containing 40 parts of Aroclor 1268 showed up very well in exposure tests of fourteen months at 45° angle in Florida. The Aroclor 1268 is used to give a velvet-like appearance to low-gloss varnish, probably by recrystallization of Aroclor as varnish dries. Varnish is 50% solids with 50 parts mineral spirits, 50 parts turpentine, 50 parts Celite 110, 6 parts Bentone, 40 parts Micromica (C-300 English Mica Company) and 3 parts anti-skinning agent. Also used is Cobalt drying agent and zirconium dry catalyst. Expected use is a varnish for cedar or redwood.

ALKYDS

JOHN ELWOOD has an account that uses Aroclor 1254 and 5460 in an alkyd in combination with a wax for the flame proofing of Christmas Trees.

The use of Aroclor compounds increases the adhesion of SHORT OIL varnishes. National Paint, Varnish, and Lacquer Association. Science Section Circular #555, 100-103 (1938)

MISCELLANEOUS

In looking over the miscellaneous category, which is too minor to report, we find that Aroclors are being used in both ETHYLCELLULOSE and CELLULOSE ACETATE BUTYRATE for CABLE LACQUERS.

WALLY HILLIARD reports he has a customer using Aroclors in a floor wax in combination with other waxes because of the melting point of the Aroclor 5460.

FRANK GUIGNON reports he has a customer that uses Aroclor 5460 as a sole binder with metallic pigments because of the excellent resistance of the Aroclor compounds with regards to anti-tarnishing properties on the pigments.

The use of Aroclor compounds in ALLYL STARCH emulsions including preparation and hardness is discussed in U.S.D.A. ---- Circular AIC - 351 (1953).

BILL DAMRON has a customer using Aroclor 1254 in a new non-flammable thermoplastic icicle for Christmas Trees.

A WATERPROOFING composition for wood is composed of Aroclor 5460 plus other ingredients dissolved in solvent. The coating drys to a tack-free, easily-painted surface. U.S.P. 2,549,127 by Donald D. Pew assigned to Stopall Waterproofing Manufacturers Inc., Kalamazoo, Michigan

AN ANTI-STATIC coating for plastics is made of acrylic pol; Aroclor compound dissolved in suitable solvents. U.S.P. 2,64(Eleanor G. Sheridan, Luther L. Yeager, and John Bjorksten assi Nash-Kelvinator Corporation.

JAKE ARBOGAST gave figures on availability of Montars. This is all going into sealing compounds for automotive use.

The technology employed by one of WALLY SCHALK'S accounts was so unlike other aspects requiring plasticizer usage, he was at a loss to recommend plasticizers. Instead, he sent the customer one of our Aroclor booklets. Subsequently, the customer requests samples and informed Wally that the Aroclors imparted some rather unusual and some highly desirable artistic effects to this system.

JOHN LONSBERG has an account that uses Aroclor 4465 in a special floor paint which is mixed with an abrasive to give non-slip properties. The majority of this is for government use at present.

AN AEROPLANE PROPELLER ICE PREVENTING coating composed of polyisobutylene and an Aroclor compound. U.S.P. 2,434,208 by Richard S. Gaugler and Hugh W. Guenther assigned to General Motors Corporation, Dayton, Ohio.

A SEALANT OR COATING for sealing an anodized oxide coating formed on aluminum is made by dissolving 1%-5% of an Aroclor compound in a suitable solvent. U.S.P. 2,698,262 by Frederic Balmar, Versailles, France.

ADHESIVES AND SEALERS

TYPE	VOLUME	PRACTICAL POTENTIAL	AROCLOR PRODUCTS USED	# Customers	# Bulk or TL Customers	Adhesion	Cost	Oxidation	Chem. or Corrosion Resistance	Flame Resistance	Melt Point	Viscosity
POLYVINYL ACETATE EMULSION	Large	2	1232, 1254, 1248, 1221, 1242, 1260	19	7	17	19	1	1	3		5
POLYVINYL ACETATE HOT MELT	Large	4	1248, 1254, 5460	4	2	3	3	-	-	-	1	-
RUBBER	Good	5?	1254, 1262, 5460, 1260	7	1	6	6	-	-	5	-	-
RUBBER (THIOKOL)	Good	3	1254, 1260, 1221	2	1	-	1	-	-	1	-	1
ASPHALT	Minor	20	Montar, 1254, 5460	3	0	1	1	-	-	-	-	-

POLYVINYL ACETATE EMULSION ADHESIVES

The Aroclor compounds are widely used in emulsion adhesives. If you will remember we used to make Ortho-Nitrobiphenyl. When this product became unavailable, we ran a program to try to replace it with Aroclor compounds. In this we were highly successful. The Aroclor compounds offered the advantage of being liquid, low in color, and easy to mix into the vinyl acetate emulsion. We find customers using them for adhesives, for cartons, envelopes, industrial equipment, and paper board boxes.

POLYVINYL ACETATE HOT MELT

Here is a large field that is growing rather rapidly. This type of hot-melt adhesive is used to bind the quarter paper, back novels, Reader's Digests, etc. It has offered real economies to the publisher because of its rapid set characteristics. The solid Aroclor 5460 is used to make a formulation that is non-tacky at room temperature and is a fluxing aid. The liquid Aroclor plasticizes the composition.

A SEALING COMPOUND for cans to contain alcohols is comprised of a vinyl chloride/vinyl acetate copolymer, an Aroclor compound, Santicizer B-16, and suitable solvents and pigments. U.S.P. 2,392,412 by John E. Robinson and Paul W. Millilot, Jr. assigned to American Can Company.

RUBBER ADHESIVES

We were surprised to find out the amount of Aroclor compounds that are being sold in rubber adhesives. Here the low cost, the adhesion and flame retardancy of the Aroclor is of prime importance. With regards to end applications, we find that Aroclors are being used in rubber adhesives for rug backings, flooring adhesives, and tape mastics. In addition, one company is making an emulsion adhesive based upon polyisobutylene and Aroclor.

RUBBER (THIOKOL)

Here is another sleeper. The quantity that we are moving in this field once again caught us by surprise. Evidently, the Aroclor compounds are one of the few materials that give high compatibility and flame retardancy with the Thiokol material. The primary end use is in sealing compounds for aluminum windows, industrial applications, curtain wall construction, etc. The normal range of application will be anywhere from 10 parts of Aroclor up to 50 parts of Aroclor.

FRANK GUIGNON has a customer currently working on a polysulfide synthetic rubber development. The end product will contain about 50% Aroclor 1221. The finished product is to be used for flexible molds, electronic potting, and building sealants. Aroclor functions as a plasticizer in the formulation.

MISCELLANEOUS

The Aroclor compounds are used in a variety of miscellaneous adhesive applications. The following references may prove valuable talking points at specific accounts.

A SEALING COMPOUND for the joints of conduits and contains effective form -67°F to 212°F is made by mixing approximately equal parts of amorphous graphite and an Aroclor compound. U.S.P. 2,471,010 by Laurence L. Rector, Fort Worth; and Charles L. Cron, Houston, Texas.

A SEALING AND ANTI SEIZE pipe joint compound is made of powdered graphite, an Aroclor compound, and a small amount of solvent. U.S.P. 2,508,596 by Clarence H. Cox, Clayton, Missouri.

A BOOKBINDING hot-melt adhesive composed of a viscous linear polyamide resin and an Aroclor compound (40%-65% chlorine). U.S.P. 2,612,463 by Rodney G. Brown assigned to E.I. DuPont de Nemours and Company, Wilmington, Delaware.

LEATHER and SHOE heat activated adhesive composed of Butadiene-Acrylonitril rubber copolymer, basic zinc carbonate, a vinyl chloride/vinyl acetate copolymer, and a solid Aroclor compound dissolved in a suitable solvent. U.S.P. 2,685,572 by John L. Perkins and Edwin E. Sylvester assigned to B. B. Chemical Company, Boston, Massachusetts.

METAL FOIL adhesives that can be applied hot or cold comprised of 25% of a liquid Aroclor compound, 50% of a solid Aroclor compound and 25% of a para coumarone-indene resin. U.S.P. 2,096,110 by Harry Kittredge and Sylvester J. Broderick assigned to Foilfilm Inc., Dayton, Ohio.

A HEAT ACTIVATED adhesive showing resistance to cold flow composed of approximately 100 parts of paraffin wax, 96 parts of Aroclor 5460, 45 parts of coumarone resin, and other ingredients. U.S.P. 2,376,778 by Ernest L. Kallonder assigned to Dennison Manufacturing Company, Framingham, Mass.

PUTTY made with the Aroclor compounds are non-hygroscopic, flame resistant, have excellent adhesion and remain flexible, soft and usable indefinitely. U.S.P. 2,743,188 by Samuel N. Hunter assigned to Hunter Metallic Products Corporation, East St. Louis, Illinois.

JOHN OREM reports that Jack has evaluated many plasticizers and finds Aroclor 1254 to be about the best with the epoxy systems. He has formulated a soft epoxy plasticized with about 30% of Aroclor 1254. Its use would be for a socket sealer. The epoxy cures at 350°F in one hour with an amine curing agent; will set up at room temperature in two days. Jack finds this formulation very stable in the presence of high heat of about 350°.

A thermosetting OPTICAL cement composed of dialkyl phenyl phosphonate and a viscous liquid Aroclor compound. U.S.P. 2,678,586 by John J. Lugert assigned to Eastman Kodak Company, Rochester, New York.

POLYSTYRENE WALL TILE EMULSION ADHESIVE composed of polystyrene emulsion, clay, Aroclor compounds, and other ingredients. The resultant adhesive has excellent adhesive characteristics and is waterproof. U.S.P. 2,486,756 by John F. Murphy and Russell Omadahl assigned to Monsanto Chemical Company, St. Louis, Missouri

PLASTIC APPLICATIONS

TYPE	VOLUME	PRACTICAL POTENTIAL	AROCLOR PRODUCTS USED	# Customers	# Bulk or TL Customers	Adhesion	Cost	Flame Resistance	Extraction	Chem. or Corrosion Resistance	Viscosity
EPOXY	Fair	5	1248, 1262, 5460	2	1	-	-	-	-	-	-
PVC PLASTISOL	Fair	3	1254, 5460, 1262	7	0	4	5	6	-	1	1
PVC COMPOUND	Minor	3	5460, 1254, 1268, 1260	3	1	-	2	2	1	-	-
PHENOLIC	Minor	10	2565, 1268	2	0	1	1	1	-	-	-
CELLULOSE ACETATE BUTYRATE	Minor	15	5460, 1254	2	0	1	2	2	1	-	-
POLYESTER	Minor	40	1268, 5460	3	0	-	-	3	-	-	-
SARAN	Minor	20	1254	1	0	-	-	-	-	-	-
CHLORINATED RUBBER	Minor	5	1232, 1254	1	0	-	-	-	-	-	-

PLASTIC APPLICATIONS

The low cost flame resistance and adhesion characteristics of the Aroclor compounds were most commonly mentioned in the plastic applications.

EPOXIES

Once again we are pleasantly surprised to find the volume of Aroclor that was moving in epoxy resin applications. Specific details on how these products were being used and the type of end applications were not available. The plasticization and the flame retardancy plus chemical resistance were the three most important reasons.

One of NORM JOHNSON'S accounts is planning to manufacture a coil from a flame retardant epoxy formulation utilizing Aroclor 1260. This flame retardant epoxy formulation has passed their customer's requirements in initial testing.

BILL DAMRON reports the customer is using Aroclor 1254 in a self-extinguishing laminated phenolic and epoxy application for printed circuit work.

POLYVINYL CHLORIDE

In the PVC plastisol field and in the compound field we find sizable volumes of Aroclors being used. The solid Aroclors are used in compounding primarily for processability while the liquid Aroclors are used in plastisols for viscosity stability and flame resistance. Also, in plastisols the solid Aroclors are used because of their low volatility and excellent adhesion.

Vinyl resins modified with Aroclor compounds are usable in making molds for thermosetting resins. U.S.P. 2,525,177 by William Lockwood assigned to Calresin Corporation of Culver City, California.

CURT SINGLETON passed along one of Bill Grosse's tip items. The tip of using 40 PHR of Aroclor 1268 was successful in a problem they have had wherein a prospect wanted a plastisol for dipping gloves but wanted a velvet feel to the coating.

Aroclors are used in foamed plastisols to control the blowing of the foam and in glove dipping to impart chemical resistance.

PHENOLIC MOLDING

In phenolic molding the Aroclor compounds are utilized as flow aids in grinding wheels and in brake linings.

CELLULOSE ACETATE BUTYRATE

In cellulose acetate butyrate the Aroclors are commonly used in hot melt applications. Here we would recommend adequate ventilation, of course. The solid Aroclor melts at the dipping temperature, but does not cause excessive tackiness when the part is cooled.

A HOT MELT coating comprised of high butyryl cellulose esters and Aroclor compounds. U.S.P. 2,481,687 by Martin Salo and Harold F. Vivian assigned to Eastman Kodak Company, Rochester, New York.

A TRANSLUCENT PAPER BASE is made by impregnating the paper with a hot melt containing a high percentage of an Aroclor compound plus resin and overcoating with plasticized hot melt. U.S.P. 2,635,970 by Martin Salo and Harold F. Vivian assigned to Eastman Kodak Company, Rochester, New York.

MISCELLANEOUS COMPOUNDS

Of course, the Aroclor compounds are widely used in a lot of miscellaneous resins. Some of these applications involve only one or two customers of rather insignificant nature. However, we thought the following references might be of interest to you.

POLYVINYL BUTYRAL resins modified with Montars show good heat and humidity stability. U.S.P. 2,506,014 by Francis J. Curtis assigned to Monsanto Chemical Company, St. Louis, Missouri.

POLYSTYRENE molding products made non inflammable with a solid Aroclor compound possesses good electrical properties. U.S.P. 2,454,255 by Joseph R. Mores assigned to Monsanto Chemical Company, St. Louis, Missouri.

A FUNGICIDAL HOT MELT INSULATING compound composed of resins, an Aroclor compound, a fungicide and other materials. U.S.P. 2,556,451 by Howard E. Smith assigned to Insul-X Corporation, Brooklyn, New York.

BILL MADDOX reports that Aroclor 1268 is, apparently, doing quite a job thus far---used as a flame retardant in their silicone rubbers.

A customer of LEE JOHNSON is using regularly a combination of Aroclor 1254 and Aroclor 1268 in asphalt as a flame retardant. The combination of Aroclor and asphlat is eventually coated onto paper.

Aroclor compounds are used in the colloid layer of PRINTING FORMS U.S.P. 2,291,673 by Fritz Albers and Edward Schloemann assigned to General Analine and Film Corporation.

A HOT MELT coating for webs of paper or textiles composed of polyethylene, terpene resins, an Aroclor compound, and paraffin. U.S.P. 2,453,644 by Walter C. Steinkraus, Chicago, Illinois.

One of BILL DAMRON'S customers said Aroclor 1254 was used because of its fire resistance into resin material products. They are using it in two applications: wax paper coatings for paper converters and manufacturing liquid wax compounds for treating electrical component parts.

A RUBBER composition with good mechanical properties and improved fire resistant properties is made by adding 20 parts of chlorinated rubber to 80 parts of Aroclor 1260. Heat until the rubber is dissolved. Cool and add to 100 parts of rubber plus fillers and curing agents. U.S.P. 2,143,470 by Wilhelm Becker and Albert Kock assigned to I.G. Farbenindustrie Atkiengesellschaft, Frankfort-on-the-Main, Germany.

A HEAT RESISTANT INSULATION compound composed of rubber and Aroclor compounds show good properties. U.S.P. 2,416,955 by Samuel J. Rosch assigned to Anaconda Wire and Cable Company, a corporation of Delaware.

Aroclor compounds are used to plasticize POLY p XYLENE compounds and filaments. U.S.P. 2,763,630 by James K. Hubbard assigned to E.I. DuPont de Nemours and Company, Wilmington, Delaware.

Aroclor 1260 is used in a low flammable, STERILIZABLE HAIR BRUSH made from Ethylcellulose. U.S.P. 2,326,811 by David R. Wiggam and William Koch assigned to Hercules Powder Company, Wilmington, Delaware.

MISCELLANEOUS

APPLICATION	VOLUME	PRACTICAL POTENTIAL	AROCLOR PRODUCTS USED	# Customers	# Bulk or Tg Customers	Adhesion	Cost	Extraction Resistance	Melting Point	Flame Resistance	Moisture Resistance	Oxidation Resistance
HOT MELT WIRE COATING	Large	1.2	5460, 5060, 4465, 1260	4	3	-	1	-	-	3	1	-
CARBONLESS CARBON PAPER	Large	1.5	1262	1	1	-	-	-	-	-	-	-
CASTING WAX	Good	4	5460, 4465, 1254	7	1	-	2	1	2	-	-	-
CARBON IMPREGNANT	Minor	3	5460, 1268	2	0	-	-	2	-	-	2	-
TACK RAGS	Minor	1.5	1262, 1254	1	0	-	1	-	-	-	-	1
ASPHALT ROOFING	Minor	15	Montars 3,4,5	1	1	-	1	-	-	1	-	-
CLOTH IMPREGNANT	Minor	10	1254, 5460, 1268	2	0	-	-	-	-	1	-	-
INSECTICIDE CARRIER	Minor	10	5460	2	0	-	-	-	-	-	-	-
PRINTING INK	Minor	30	5460, 1254, 1221	3	0	-	-	-	-	-	-	-
PIGMENT GRINDING	Minor	30	1254, 4465	2	0	-	-	-	-	-	-	-
PIGMENT CARRIER	Minor	30	1248	1	0	-	-	-	-	-	-	-
AIR FILTER MEDIUM	Minor	5	1254	1	0	-	1	-	-	1	-	1
DUST SUPPRESSANT	Minor	30	1254	1	0	-	-	-	-	-	-	-
FLOW STUDY	Minor	3	4465	1	0	-	-	-	-	-	-	-

The miscellaneous applications for Aroclor cover a wide variety of applications.

HOT MELT WIRE COATINGS

In this application the market, while huge, is limited to a few companies that seem to control the bulk of the business. Here the Aroclors are blended with wax and phosphate esters to make hot melts that are then used to flame-proof cables. Unfortunately as vinyls increase in volume in the electrical trade, the application for Aroclors as an impregnant decrease.

CARBONLESS CARBON PAPER

This is an application that is patented. However, we have many other requests for Aroclors in carbon paper applications, some of which seem to be showing a fair deal of success.

CASTING WAX

The investment casting field is one that has been reborn. It is sometimes called the "lost wax" technique. We have made a sizable survey and you will be hearing more about this later. As it now stands, however, you can see we have a good many customers and the current volume is good. The flame resistance, the high impact strength, short melting point, and other desirable characteristics imparted by the Aroclors will enable us to give you a full story as soon as we are able to contact a few more people and verify their requirements.

AN ELECTRICAL INSULATING material is made by impregnating the base material with a mixture of styrene monomer and an Aroclor compound followed by polymerization. U.S.P. 2,147,824 by John Krauss Webb assigned to International Standard Electric Corporation of New York, New York.

CLOTH IMPREGNANT

Aroclors are used to impregnate felts for the Navy, for sound deadening characteristics in ships; they are also blended with wax to impregnate asbestos cloth to impart electrical properties. Other applications for Aroclors as impregnants are as follows:

SILICA TEXTILE materials that have been leached and then coated with a solution of Aroclor 5442 show improved abrasion resistance. U.S.P. 2,686,954 by Leon Parker assigned to the H.I. Thompson Company, Los Angeles, California.

RANDY GRAHAM has a customer currently using a mixture of Aroclor 5460 and Aroclor 1254 as an impregnant for welding cloths which are used in fabrication plants. He said that he actually flame proofs these cloths so that when sparks from welding hits the cloth no holes are burnt through. He is currently selling this to a steel company for their welding rooms which use these canvas cloths as walls to cut down on the amount of flying molten metal which occurs when welding. It might be that it could be extended to pup tents and the tent industry and maybe added in combination with some waterproofing chemical.

GEORGE STEWART recommended the use of Montars to a customer who felt some of the air-conditioning companies such as Carrier plan to specify FIRE-RESISTANT ASPHALT FELT in 1961 for use in all air conditioning equipment.

A composition to give good resistance to both flame propagation and after flow is made by a combination of Aroclor compounds plus aldehyde condensation resins. U.S.P. 2,461,538 by Earl K. Fisher assigned to Interchemical Corporation, New York, New York.

A flameproofing composition is based on a mixture of a thermally unstable chlorinated resinous material, zinc carbonate, and other ingredients plasticized with a flameproofing plasticizer such as an Aroclor compound. U.S.P. 2,378,714 and U.S.P. 2,326,233 to Martin Leatherman, Hyattsville, Maryland.

INSECTICIDE CARRIERS

There has been a number of government articles which appeared on the use of Aroclors to extend the life of volatile insecticides for non-food prompt uses. Shown below are a series of references which may be of interest to your insecticide potentials:

Chlorinated Polyphenyls to improve Lindane Residues. W. N. Sullivan and I. Hornstein in Journal of Economic Entomology Volume 46, February 1953, Pages 158-159.

Improving Deposits for controlling insects outdoors. W. N. Sullivan, Irwin Hornstein, A. H. Yeomans, and Ching-Hsi Tsao, Journal of Economic Entomology, Volume 48 No. 2, Pages 153-154.

Aroclor 5460 extends life of Aldrin and Lindane but not DDT. Thought more volatile first two slowly escapes to surface. Thought DDT is marked by Aroclor 5460. Residual Effectiveness of Mixtures of Organic Phosphorous Insecticides with Chlorinated Terphenyls. Irwin Hornstein, William N. Sullivan, and Ching-Hsi Tsao in Journal of Economic Entomology, Volume 48 No. 4, August, 1955, Pages 482-483.

Lowering the Volatility of Lindane Cuttle Sprays by Addition of Film Forming Material. Irwin Hornstein, W. S. McGregor, and W. N. Sullivan in Agriculture and Food Chemistry, Volume 4, No. 2, February 1956, Pages 148-149.

The Use of Chlorinated Polyphenyls to Increase the Effective Insecticide Life of Lindane. Edward J. Duda - Journal of Entomology Soc, 218-219, (April 1957). Aroclor 5460 and Lindane may exhibit a synergystic effect in controlling elm leaf beetle.

PRINTING INKS

How many times have all of us thought that more Aroclors should be used in printing inks. At the present time a rather small amount is consumed in this field. Although as the following references show, there is considerable interest:

PRINTING INKS for metal application are prepared by dispersing pigments in EPOXY resins and Aroclor compounds. The inks show no discoloration upon baking and provide a smooth strong film. U.S.P. 2,736,719 by Hugo

P. Stockmayer assigned to Sun Chemical Corporation, Long Island, New York.

A WET FINISHING varnish composed of an alkyd resin in solvent modified with a liquid Aroclor compound and polymethyl silicone. U.S.P. 2,736,355 by Jerome A. Ryan assigned to the The Sherwin Williams Company, Cleveland Ohio.

For Dick Tracy fans, JIM COMPTON has a customer currently using Aroclor 1221 at about a 1% level in an invisible ink formulation used to trace cutting pattern on Chenille rugs and spreads. Recently had to switch dye ingredients and Aroclor 1221 would not work with new dye, but Aroclor 1262 did work.

PIGMENT GRINDING AND CARRYING

This is a natural application for the Aroclor compounds. The customer by his choice of Aroclor can develop the type of viscosity he desires. The Aroclors give rapid wetting action into most pigments.

BILL MORLOCK has an interesting application where the customer is dispersing pigment and catalyst in Aroclor for polyester applications.

Aroclor 5460 is an excellent "wax" for DISPERSING PIGMENTS in solvents. U.S.P. 2,772,982 by Vincent C. Vesce assigned to B. F. Goodrich Company, New York, New York.

Aroclors are excellent wetting agents for the preparation of METALLIC PASTE PIGMENTS. U.S.P. 2,713,006 by Samual N. Hunter assigned to Hunter Metallic Pigments, East St. Louis, Illinois.

MISCELLANEOUS

The Aroclors also find a lot of miscellaneous applications, some of which are discussed briefly below:

Solid powdered Aroclor compounds are used as a DELUSTERING AGENT for rayon. U.S.P. 2,111,449 by James W. Humphrey and John W. Pedlow assigned to American Viscose Corporation

This company using Aroclor 1248 to thicken ceramic slurry reports JOHN ELWOOD.

RAY GREENE reports a metals laboratory has a rather unique use of Aroclor 1268. It is melted and then used to fill the pores of nickel sponge. The sponge can then be machined without destroying the cell structure. After it has been fabricated, it is brought to a high temperature and the Aroclor is probably vaporized off.

A WATER SOLUBLE SOIL-POISON concentrate is made by blending an Aroclor compound, trichlorobenzene, pentachlorophenol, isopropyl alcohol, and other materials. U.S.P. 2,588,318 by Paul G. Benignus assigned to Monsanto Chemical Company, St. Louis, Missouri.

Exhibit 16

NEWS

Monsanto

FOR RELEASE IMMEDIATELY 1970

E. V. John
(314) 694-2891
PUBLIC RELATIONS DEPARTMENT
Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166

MONSANTO CITES ACTIONS TAKEN ON ENVIRONMENTAL ISSUE

ST. LOUIS, July 16 -- Monsanto Company, sole U.S. producer of an industrial chemical called polychlorinated biphenyl (PCB), today said recent political charges and sensational headlines about the chemical causing "a major ecological crisis" completely ignore voluntary actions the company has taken to restrict use of the material.

"Our program began back in 1968 with the proper identification and measurement of PCB in the environment and will conclude this year by our unilateral action to restrict its use," Howard L. Minckler, company vice president and general manager of its Organic Chemicals Division, said.

He added that Monsanto had not been pressured into action by any legislation or organized group. "We have taken decisive action based on evidence that PCB is a persistent chemical which builds up in the environment."

-more-

DEPOSITION EXHIBIT 35 6/26/14 LG

MCL000647

--2 MONSANTO: MINCKLER'S REPLY TO PCB CHARGES xxx environment."

Commenting on a recent report that PCB can induce birth defects in animals, Minckler said, "Monsanto is not aware of any scientific data that indicates polychlorinated biphenyls may cause birth defects. The results of comprehensive toxicity studies, sponsored by Monsanto and using the usual species of laboratory animals, have failed to produce such effects.

"Scare tactics and sensational reporting do not serve the public interest nor solve ecological problems," he said. "Only a few reports have stated why PCBs were ever developed and why they are used today. Nor have the consequences of not using PCB been explained.

"What should be emphasized," Minckler continued, "is that PCB was developed over 40 years ago primarily for use as a coolant in electrical transformers and capacitors. It is also used in commercial heating and cooling systems. It is not a 'household' item.

"Anyone who lives in a large city is familiar with power failures. During periods of peak power needs, air conditioning and refrigeration fail, lights go out and commuters are stranded. If power companies were to remove PCB from equipment, we have been told that major blackouts would occur throughout the world.

-more-

--3 MONSANTO: MINCKLER'S REPLY TO PCB CHARGES xxx world.

"PCB is used in electrical equipment as a safety fluid. It has replaced combustible oil products which have, on many occasions, exploded and burned, causing deaths and injury to human life. Today state and local laws all over the country require the use of non-flammable fluids in certain electrical equipment as a safety feature. At the moment, there are no substitutes available which equal the safety performance of PCB."

Monsanto said it intends to continue selling PCB for "closed-system" uses such as electrical components and heat-transfer systems. "With rigid control over where the product goes, how it is handled and disposed of, we believe the safety functions of the product can continue to serve society and the environment can be protected," Minckler said. "We are discontinuing sales into 'open systems' -- adhesives, sealants, chlorinated rubber, specialty paints, etc.

"For other uses, such as fire-resistant hydraulic fluids, where PCB cannot be strictly controlled, we have reformulated some fluids and they are on the market. The new products contain other fire-resistant ingredients. We will continue to develop alternate formulations which do not contain persistent PCB. We will not abandon hydraulic fluid users," Minckler commented, "as has been reported."

-more-

--4 MONSANTO: MINCKLER'S REPLY TO PCB CHARGE xxx reported."

Monsanto has also established a new system for disposal or recycle of spent PCB. A special high-temperature incinerator will break down PCB into harmless materials. The company also regenerates spent fluids for reuse. The incinerator will be offered to customers who cannot otherwise destroy or regenerate their old fluids.

"Although loss of PCB from our manufacturing plants has been negligible, we have further tightened up our production techniques and installed new pollution abatement devices," the Monsanto executive said.

"I repeat," Minckler concluded, "our program was initiated and conducted by Monsanto alone. It will be concluded this year. We believe it is a position any responsible company would take."

-oOo-

Exhibit 17

bcc: W. R. Richard
Tom Ford
H. S. Bergen
J. E. Springgate

March 24, 1969

Mr. Harry Chatfield
Los Angeles County Air Pollution
Control District
434 South San Pedro Street
Los Angeles, California 90013

Dear Mr. Chatfield:

Enclosed is a copy of the physical properties of our Aroclor compounds I promised you by phone. We have added the oral and skin absorption toxicity to the bottom of this list to give you some idea of the relative toxicity of these compounds. You will notice that they are not particularly toxic by oral ingestion or skin absorption. In addition, I have enclosed a copy of a paper that was printed in the American Industrial Hygiene Association quarterly in June, 1956. This paper discusses the vapor toxicity of Aroclor 1242 and Aroclor 1254. As I told you on the phone the 12 prefix in this case means biphenyl and the 42 or 54 suffix in this case represents 42% and 54% chlorine by weight, respectively.

We at Monsanto cannot understand the origin of the materials reported in the recent newspaper articles on the West Coast. These compounds are utilized generally in enclosed systems and very little would normally be expected either in the air or in the liquid discharges from a using industry.

If we can provide you with any additional data we would be glad to do so.

Sincerely,

Jack T. Barrett
Manager, Pollution Abatement
and Industrial Hygiene

JTG:cjs
Enclosures

Exhibit 18

Monsanto

ORGANIC CHEMICALS DIVISION

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

March 27, 1969

Mr. Fred H. Dierker
Executive Officer
State of California-Resources Agency
San Francisco Bay Region
Regional Water Quality Control Board
364 Fourteenth Street
Oakland, California 94612

Ref: File No. 2119-1075

Dear Mr. Dierker:

This letter is written in response to your letter dated March 7, asking several questions concerning polychlorinated biphenyls ("PCB") manufactured by Monsanto. Responses to each of your questions are set forth below, numbered in accordance with your letter.

1. We have recently contracted with a consulting laboratory to undertake fish toxicity studies on PCB's. Because of the low solubility of PCB in water, it may be difficult to obtain a 96-hour TL_m. Depending upon the results of the initial studies, we may conduct 30-day exposure experiments.

2. Attachment A shows the general physical characteristics of PCB. Information set forth on the bottom of these pages shows the results of acute animal toxicity studies showing the oral LD_{50} in rats and the minimum lethal skin dose when applied to rabbits. You will note that these results were obtained using undiluted samples or as a corn oil suspension solution depending on the viscosity and solubility of the materials.

NEV 031051

780589

3. & 5. Attachment B shows the results of studies of chronic inhalation. You will note in the table describing the properties of various PCB's that the liquid materials have extremely high distillation ranges and that waxy or resinous materials have to be distilled under high vacuum. These data attest to the low vapor pressure of the materials at ambient temperatures.

PCB finds primary use in applications requiring chemical stability, good dielectric properties, fire resistance, low volatility and water insolubility. When used in dielectric fluid, PCB is hermetically sealed in capacitors and transformers, designed for 20 to 30 years life at temperatures at or near ambient temperatures.

Plasticizer PCB is found primarily as a plasticizer for surface coatings such as corrosion resistant paints, industrial adhesives and as a sealant such as window sealants. These applications do not include automobile tires, or floor tile. These applications of PCB emphasize its inertness and low volatility to provide long service life for the product without loss of flexibility. In normal use, PCB plasticizer applications are ambient temperature environments presenting no special health problems. In view of PCB's chemical inertness, we would anticipate no problems associated with the environment from refuse dumps.

PCB finds further application in industrial (excluding aviation) hydraulic and heat transfer systems. As in the case of dielectric applications, these systems are designed for essentially indefinite fluid life.

4. PCB is essentially insoluble in water, which is a property valued for most of its industrial applications. The solubility of PCB varies with the number of chlorine atoms. Solubility in tap water at 25°C. is as follows:

Material	Solubility in Water
PCB - (42% chlorine by weight)	203 ± 10 ppm
PCB - (48% " " "	106 ± 14 ppm
PCB - (54% " " "	50 ± 2 ppm

This data indicates that the most highly chlorinated PCB's are the least soluble in water. Annual consumption in the Bay Area is less than 500,000 pounds for all PCB applications.

6. It is a long standing policy at Monsanto not to disclose information concerning our customers, including the customer's name. However, we desire to cooperate with you to the fullest extent practicable in this matter. Should you desire to visit typical PCB users we will be happy to approach our customers to arrange a visit.

7. We advise persons using PCB products to take normal precautions associated with handling most synthetic materials. If accidentally spilled on hands, no serious skin irritation should occur. However, PCB has a solvent action (similar to paint thinner) on the fats and oils of the skin and prolonged contact may lead to drying and chapping of the skin.

   In the event of contact, the skin should be washed with soap and water. Saturated clothing should be removed and dry cleaned. Spills may be cleaned up with rags, sawdust or absorbent clay. Eye contact may result in painful irritation but should cause no permanent damage to tissues. In the event of eye contact, the eye should be flushed with large amounts of water. As with all eye first-aid, a physician should be consulted. To relieve irritation, physicians have used a 1% Pontocaine as well as ophthalmic cortisone acetate solution, or castor oil.

   Infrequent exposure to PCB vapor should not cause ill effects. However, prolonged exposure to high vapor concentrations should be avoided.

After many years of experience with PCB, it is our understanding that cases of harmful effects resulting from the industrial use of PCB have been extremely rare. We believe this is due largely to low volatility which reduces possible inhalation at ambient temperatures.

We sincerely trust that this answers the questions contained in your letter. As further information becomes available in which we feel you might be interested, we will pass such information on to you.

Yours very truly,

for Howard S. Bergen
Director, Functional Fluids

HSB:pep
Attachments
BCC: P. S. Park
E. Wheeler/J. Garrett
D. A. Olson
P. Benignus
W. Weycheff
D. Pogue
N. T. Johnson
W. R. Richard

P. S. to H. S. Bergen only: Howard - Some ideas for your consideration may be appropriate based on my discussions with Phocion Park, J. Garrett and Bill Richard while preparing this response.

1. Phocion emphasizes that nothing should be volunteered on these type requests unless specifically requested, because of mis-interpretations and needless chances for confusion. We can always add but never subtract from something written.

2. We may want to consider, when appropriate, a personal visit in lieu of written communications. Personnel from Monsanto at such visits should not be our

technical experts but a responsible management representative who can relate critical questions. This permits time for preparing answers that will not allow mis-interpretation.

3. Anticipating negative impact of the Time Magazine article and continued negative comments by Riseborough at UC, a personal visit by such a person may help clear the air and solidify our image of cooperation before publicity expands via partially informed sources.

4. Estimated Bay Area Aroclor usage of 500M lbs. derived from following:

Plasticizers (per C. Paton)	48M lbs.
*Dielectrics	300M
Heat Transfer	100M
Hydraulic	50M
Total	498M lbs.

*Denotes usage for initial fill of new transformers. Actual consumption in Bay Area would be significantly less, perhaps 50-90% less.

I hope the above may be of value to you.

D. M. Pogue

/pep

NEV 031055

780593

Exhibit 19

Monsanto

JUN 2 1969

FROM (NAME & LOCATION): E. P. Wheeler

DATE: May 26, 1969

SUBJECT:

REFERENCE:

TO: W. R. Richard

cc: R. E. Keller
E. S. Tucker
H. S. Bergen
J. E. Springgate
C. Paton
W. A. Kuhn
P. B. Hodges
Dave Nelson - MRC

Dave Nelson of MRC called me today to relay the following information:

1. A Mr. Bob Day in the Cincinnati Laboratories of the National Air Pollution Control Administration had called him and asked for any information Monsanto might have relating to what might happen to chlorinated biphenyls in products that might be incinerated. Day indicated that he needed the information for "his boss" John Ludwig, assistant commissioner of NAPCA in Washington by Monday, May 26.

   After trying to reach Day and finding busy circuits I called John Ludwig directly since I know him personally. Ludwig was surprised and said if the question of PCBs had come up he had forgotten it or at least didn't remember that he wanted an answer by next Monday. He offered to have Day call me directly but I told him that I would get through to Mr. Day.

   I did reach the latter and after much discussion it turned out that some member of Congress had sent a letter directly to the NAPCA offices in Washington asking what NAPCA knew about distribution of PCBs by incineration and Ludwig had passed the letter on to Cincinnati to get information for a reply.

   Mr. Day was under the same misconception as so many others concerning the widespread situation of PCBs in such things as automobile tires. I set this matter straight quoting from the company prepared statement. We then got into some detail because it became apparent that Day was not a "Knight on a White Horse" but was reasonable and objective. As we chatted further and expanded comments about mutual acquaintances, Day finally told me that he is a Monsanto employee from Pensacola fulfilling his millitary commitment as a member of the Commission Corps. in the Public Health Service.

   He indicated that the laboratory in Cincinnati may try to set up a program where waste materials containing PCBs will be incinerated (in one of the several experimental incinerators which they have there) and analyze the decomposition products. He asked if Monsanto would be in a position to provide wastes or

plastic materials containing Aroclor which they could use in their experiments. I offered to cooperate in any way we could.

He will send word back to Washington which will then be related to the member of Congress that the PCBs are not used in some of the applications which have been indicated in the public press and in general try to present Monsanto's views to wit: "We can not conceive how the PCBs can be getting into the environment in a widespread fashion and that the company is actively involved in research programs to try to shed some light on the situation."

2. Dave Nelson attended a meeting at the Federal Water Pollution Control Administration Laboratory in Athens, Georgia recently to see if there were areas where MRC could bid on government grants for research in connection with pesticide residues.

Dave says that in the course of the meeting some of the FWPCA boys raised the question as to what Monsanto at Anniston, Alabama does to control the escape of polychlorinated biphenyls or waste products getting out of the plant. Obviously Dave would not have any of the details of our programs at Anniston but passed this word on to me with the thought that we can anticipate that the Peds will be looking at creek, river or lake water and mud samples below Anniston for PCBs.

Elmer P. Wheeler

cs

Exhibit 20

July 23, 1969

Mr. A. Bruce Pyle
Assistant Bureau Chief
Department of Conservation
and Economic Development
P. O. Box 1809
Trenton, New Jersey

Dear Mr. Pyle:

In connection with your recent request for more specific information on PCB, I have enclosed several items that may be of interest.

The first is a table showing the physical characteristics and properties of our Aroclors, the trade name for our polychlorinated biphenyls.

The numerical designation of these materials is meaningful. The 1200 series are biphenyls chlorinated to the extent indicated by the last two numerals. For example, Aroclor 1242 is biphenyl chlorinated to the extent of 42%; Aroclor 1254 is biphenyl chlorinated to 54%.

The 5400 series are terphenyls chlorinated to the extent of the last two numerals. Thus Aroclor 5460 is terphenyl chlorinated to 60%. The 2500 and 4400 materials are mixtures of biphenyls and terphenyls chlorinated to 65%.;

We have typed on the bottom of the table the results of acute toxicity studies. These indicate the approximate lethal dose in rats when administered orally and the minimum lethal dose when the samples were applied to the unbroken skin of rabbits. You will note that the samples were administered undiluted or as various concentrations in corn oil depending on the physical form and solubility of the sample.

The second enclosure refers to the only published data that we now have concerning possible toxicity to fish. This enclosure is a 1957 report from the U. S. Fish and Wildlife Service showing the results of studies to determine the possible effects of chemicals to larval lampreys and fishes. The enclosure includes a copy of the title page, the page explaining the table and that portion of the table which indicates that four of the Aroclors have no effect on trout, bluegill and larval lampreys at a concentration of 5 ppm in a 24 hour test period.

The only chronic toxicity data that we have refers to the inhalation of vapors of Aroclor 1242 and 1254. Enclosure three is a reprint describing the chronic inhalation studies and enclosure four is a Hygiene Guide published by the American Industrial Hygiene Association which prescribes safe handling techniques for the use of these materials in industry.

Based on available data, manufacturing and use experience, we do not believe the polychlorinated biphenyls to be seriously toxic. At the same time we have also recommended precautions to avoid repeated and prolonged skin contact and secondary avoidance of inhalation of vapors when the materials are heated. As indicated by the distillation ranges in enclosure one, these products have extremely low vapor pressure and thus present little vapor inhalation hazard at ambient temperatures.

I don't know that I can add a great deal to your question to the use of these materials without repeating the comments in the statement which Tom Ford sent you. Their dielectric characteristics lead to usage as insulating fluids for transformers and capacitors. Transformer application is in sizes applicable to sub-stations rather than the small transformer on lines for reducing voltage for household use.

The plasticizer type application PCB's are incorporated into a polymer as an integral part of the solid material. This is the case whether the polymer is then used as an adhesive special elastomer or individual surface coating.

Contrary to some reports from the press, the PCB's are not used in rubber tires, lipstick, or the common plastic containers or films used for industrial or household packaging.

We have a considerable research effort underway to determine the toxicity of several of the PCB's in rats and dogs. We are also including three generation reproduction studies in rats. Also underway are studies with fowl to determine the possible chronic effect on the birds themselves, egg size and production, hatchability of the eggs and viability of the chicks. We will also do studies to determine any possible effect on egg shell thickness and calcium and phosphorus metabolism.

We have attempted to establish a program for determination of the possible biodegradation of the polychlorinated biphenyls but research of this type is not yet underway.

Re-emphasizing a point we attempted to make in the statement Tom sent you, we are unable at this time to conceive of how the PCB's can become wide spread in the environment. It is certain that no applications to our knowledge have been made where the PCB's would be broadcast in the same fashion as the chlorinated hydrocarbon pesticides have been. I am sure there will be much more research undertaken to clarify some of the questions that early research efforts have raised and you may be sure that we will participate in a number of these.

If I can be of any further assistance after you have reviewed this letter and the enclosures, please let me know.

Sincerely,

Elmer P. Wheeler
Manager, Environmental Health

EPW:ju

Exhibit 21

St. Louis

February 10, 1967

G. R. Buchanan - GBUCH
J. Filer - BRUSSELS
D.V.N. Hardy - LONDON
Eugene Wilde - EWILD

FILE
RAM
EPW

Mr. D. ~~Wood~~
~~LONDON~~ Brussels

We have had a rather extensive meeting, which included the St. Louis individuals receiving copies of this memorandum, on Aroclor in the air and in various fish and other living reservoirs.

The decision was that more information had to be gained, and whether this would necessitate a trip from someone in the Medical Department to the various agencies working on this problem in Europe would depend upon how easily obtainable these gaps in our knowledge are by other means than personal communication.

We are very worried about what is liable to happen in the states when the various technical and lay news media pick up the subject. This is especially critical at this time because air pollution is getting a tremendous amount of publicity in the United States.

We have been receiving quite a few communications from our customers, but the most critical one is NCR, who are very much involved with their carbonless carbon paper.

I have listed a number of points referring to information I would like to have. Some of these may be easy to answer; others might take a little bit of investigation and some might not be feasible to answer at this time. However, please let me know your ideas on each one of the following items:

1. Can we get the original articles in the Swedish press, including Dagens Nyheter? I have a good fluent Dane who translates Swedish very well and is a physician and investigator, so nothing will be lost in the translation.

2. Who were the participants in the conference referred to in your memorandum to Mr. Buchanan of January 26? Under whose auspices was it held and were there any reports issued? What were the conclusions of the conference and was any action decided upon?

MONS 031358

CV96-J-0440-E
DATE 04/02/01

PLFF EXHIBIT NO. 92

3. What was the medical institute in Sweden that was going to do the toxicological work referred to in the same memorandum to Mr. Buchanan? Who was going to pay for it and what was the scope of the investigation?

4. In LKB press release of January 10, they stated that 12 OECD nations were going to do work on this problem. Can anything be found out about the extent of this work? Who is doing it, and at what institutes?

5. What is known about the work in England at the Monks Wood Experimental Station and the Laboratory of Chemistry in London? How long has this gone on? Is it an ongoing study? What are the perimeters of the study?

6. Do we have the complete paper in Swedish of Jensen and Widmark entitled "Pesticide Analysis--Presence of Polychlorinated Biphenyls and Residual Analysis of Biological Samples"? This was referred to in D.V.N. Hardy's letter of January 12, 1967. I would like to get this original paper with the bibliography in Swedish.

7. Can I have more information about the Carlin Institute of Toxicology which was referred to in Mr. Widmark's letter to Mr. Ford of December 29, 1966? What do they intend to do? Who is the contact, and is it located in Stockholm?

By copy of this memorandum, I am asking Dr. Hardy to find out what the situation is in the two English contacts referred to in item 5.

The consensus in St. Louis is that while Monsanto would like to keep in the background in this problem, we don't see how we will be able to in the United States. We feel our customers, especially BCR, may ask us for some sort of data concerning the safety of these residues in humans. This obviously might be opening the door to an extensive and quite expensive toxicological/pharmacological investigation. Before starting this, we certainly want to find out what is going on and not duplicate any of the work. I have tried to call you for the last two days and I will be out of town next week, but I would like to call you the week of the 20th. Perhaps by then you might have some answers to some of the questions.

R. Emmet Kelly, M. D.

REK/ln

1. PCB-A NEW FISHDEATH?

2. Picture: The young salmons die in the salmons station at Älvkarleö. The Fish Pathologist, Mr. N. Johansson suspects that this is caused by PCB. A loophole in the law prevents the Authorities to take any action.

3. We have got a new environmental poison - PCB. On July 26th Småland and Östergötland (counties in Sweden) were hit by a soot and oil rain. Analysis shoe that such a rain contains among other things PCB. PCB is rather like DDT, but probably more poisonous. By eating PCB-poisoned rise-oil many people in Japan have died. In Sweden "Folhälsan" have found PCB in almost all the fish and meat they have analysed.
From 1968 to 1969 the PCB-content in analysed samples increased by 50 %. Last year 80-100% of roe and young salmons died at the Salmon Research Institute at Älvkarleö. The fishes had high PCB-content. PCB is very stable. It cannot be destroyed by living organisms and is spread in nature in higher and higher concentrations. PCB is found in fishes, birds and people all over the world.
PCB is used as cooling-oil and insulating fluid in high tension transformers and as plsticizer and alga-killer in paint and sealing compounds. Because of a loophole in the law the use of PCB cannot be stopped.

4. Investigations show that soot and oil rains of the kind that hit the coast of Småland and Östergötland on Sunday contain PCB. PCB is a environmental poison that slowly steal upon us. It cannot be destroyed by living organisms. PCB is sold without limitations. A loophole in the law prevents the Authorities from doing anything against the use of it.

MONS 031360

5. Life-dangerous environmental poison, new DDT-threat.

6. In roe and young salmons at the Salmon Research Institute in Älvkarleö the percentage of death usually is about 10-29%. High content of PCB (polychloribated biphenyls) has been found in the roe. In Sweden "Folkhälsan" has found PCB in almost all the fish and meat they have analysed. PCB is rather like DDT but perhaps it is more poisonous that DDT. "Naturvårdsverket" has done a first review of the use in Sweden. It has been classified as strictly confidential. Because of a loophole in the law neither "Naturvårdsverket" nor "Giftnämden" can stop the use of PCB. PCB is an environmental poison which slowley but surely steals upon us. The content is closed to, is on a level with, or is above the content of DDT. The use of PCB is free. What is PCB?
It is a group of chridizing hydrocarbons, a group of clorinated biphenyls tightly tied together in a syntetic way. This is manufactured by having chlor to react with biphenyl, on aromatic hydrocarbons.

In Sweden they sell three products: The Frenchmade Pydralén, the American Aroclor and the German Clophen. The most common kind here in Sweden is Clophen which is manufactured by Bayerische Anilin in Leverkusen. Two fields of application dominate: as cooling-oil and insulation-fluid in high tension transformers and condensors and as plasticizers and alga-killers in paint - and sealing compounds.

All over the world:

It seems strange that the leakage from these rather special fields of application can be the reason for nos finding PCB in fish, birds and peolple all over the world. But PCB cannot - as far as they know - be destroyed by living organisms. If it gets in us or in nature it will circulate while the quantities increase.
A practical thing in a few technical situations becomes a grewing environmental danger.
Assistant Prof. S. Odén at "Lantbrukshögskolan" "takes finger prints" of the cities in Sweden from the environmental poison point of view by researching the content of poison in sludge of the cleaning plants. They looked for PCB in 63 cleaning plants and found it in all of them. The content was highest in the industrial areas. The content has increased with ca 50% between the tests in 1968 and 1969. Mr. Odén says that htere is no other reason for this than that PCB has been used more and more.
"Naturvårdsverket" has no right to demand the PCB-consumers to put their cards on the table.

The customer list tells:

Manager General V. Paulsson says: "Against promise of secrecy we succeeded in taking part of the Swedish PCB-sellers' customer list. I am afraid we are not allowed to publish this material".
"Naturvårdsverket" asked Ing. A. Kjällman to visit the companies which use PCB. We wrote to about 20 paint companies and electrical industries and visites some of them.
This is the quantity used in Sweden every year: 500 tons in condensors and transformers, 55 tons in PVC - and rubber paint, 15 tons in shipbottom paint, 35 tons in sealing compounds.
-"At some companies they throw it in a dump, at other places they throw it in the waste-water," Ing. Kjällman says.You notice PCB in paint, when you wash dishes and when you scrape boats.
PCB is undestroyable through burning. It cannot be disolved even if you boil it in concentrated Nitric Acid.

The transformers leak:

In electrical works they use it in a closed system. No oil or cooling fluid will leak out. When they change the oil they return the old oil to the manufacturer. But sometimes there are interuptions of the service in the transformers. "Some time ago we were warned that 3 tons transformer-oil had leaked out into a lake" says Mr. S. Jensen at "Naturvårdsverkets specialanalytiska laboratorium", Uppsala It was mineral oil. But it could as well have been PCB-oil.

At the Salmon Research Institute in Älvkarleö breeding salmons swim in the water from Dalälven river. Last year they found that a great number of the roe and the young salmons died. Alanysis at "Naturvårds-verket" showed high content of PCB in the progeny.
-"We are very worried about what will happen in the future," N. Johanson says, but we have not enough material yet to be sure it is PCB that kills the salmon progeny. What we know for sure is that the older the salmon female are the higher the PCB-content is in the roe and in the young salmons who die.

Less in wild salmons:
The wild salmons - who give material to the big salmon station - show a much smaller content of PCB. Anyway the death at some stations is as high as 35-40%. Instead of PCB there are high contents of DDT in the progeny of wild salmons, but they have not proved any connection between DDT adn the death of roe.
The environmental keepers who are more prophets than scientists say that it sure will be a day when we know that the salmons die of PCB. What else can you expect when the outleaks are free to continue?
Third part of all the salmons in Östersjön lake come of the stations ashore. To poison the progeny meens the end of salmonfishing. Even if the content in salmon not has to be so high - and today it absolutely is not - that we cannot eat the salmons.
"Folkhälsan" finds high content of PCB in the fishes from almost all the waterstreams they have analysed and even in meat, but the content in metat is lower. In Japan people have died by eating poisoned rise-oil. They know hardly anything about the Toxicological risks for human beings of the content they have now found in Swedish food. The content they have found in Japan is higher than the content here.

Might be serious:
-"The spread of these very stable poisonous materials is not enough analysed from the foodhygiene point of view", Miss G, Westöö "Folkhälsan" says. PCB might become a serious problem.
The lawmakers could never imagine that small shares of chemical and technical products from isdustries leaking out, could stay, circulate in living organisms until they (perhaps) reached highly dangerous concentrations. This is what the President of the Poison Committe, Pharmacist R. Lönngren said when he informed the Govermental Authorities for Environmental Health about this: "PCB belongs to a group of materials with qualities simular to DDT and sometimes worse that that and I think they are a problem we will have reason to analyse more. But there is as far as I know no part of the law that gives any Authority the right to take any action. This is absolutely one of the loop - holes in our law regarding the protection of environmental poisons.

The investigation takes time:
An investigation is working on a law that will stop the loopholes in our law but it will still take time. Meanwhile there is this possibility: The paint companies and the leaders of electrical idustries can take the chance to act in an environmental-kind of way themselves. For example the manufacturer of sealing compunds that leaks out 200-300 kilos PCB in Öresund every year. (Cidfish and plaice in Öresund have very high content of PCB). This also holds for the big paint company in Stockholm which is responsible for the fact that the cleaning plant in Åkeshov (near Stockholm) has to take more PCB than any other cleaning plant in Sweden.

Exhibit 22

MONSANTO

FROM (NAME & LOCATION): Medical Department - A2SA

DATE : August 6, 1971

SUBJECT : PCB Literature Search

REFERENCE : Your memo to Dr. Kelly - 8/3/71

cc: G. L. Bratsch - 1740

TO : Don-Otto Krummrich - 1740

Dr. Kelly is away from the office for the next two weeks. In his absence, I can say that we have probably the world's best reference file on the PCB situation. This includes reprints from the literature beginning in 1936 to reports issued last week.

The question of whether or not we should be doing anything different in terms of clinical or physical exams I will leave to Dr. Kelly to answer. We have discussed in the past two years the pros and cons of some special studies but have not reached any decision as to what might be in order.

Elmer P. Wheeler

/bks

MONS 029656

CV96-3-0440-E
DATE 04/02/01

PLFF EXHIBIT NO. 561